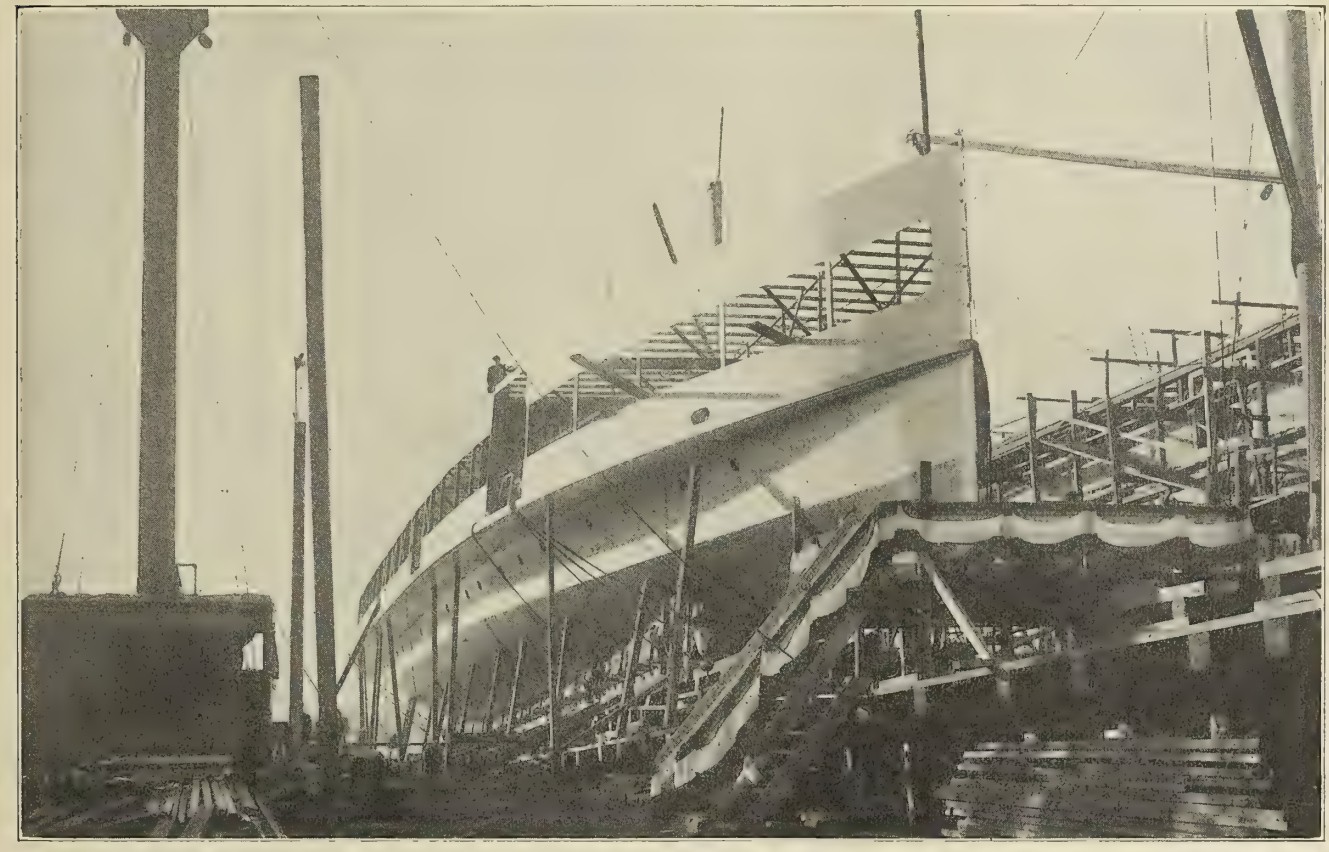
International Marine Engineering

APRIL, 1910.

THE NEW RIVER STEAMERS CITY OF PHILADELPHIA AND CITY OF WILMINGTON.

The increased traffic in passengers and freight between Philadelphia, Pa., and Wilmington, Del., has led the Wilson Line to construct two new river steamers. The two steamers which this company is running at present, the *Brandywine* and *City of Chester,* have had a splendid record. The *Brandywine,* a light built steamer, has been running every winter, and, contrary to what one would expect, is an acknowledged wonder at ice-breaking, being able to maintain her regular trips when vessels specially designed for the purpose of breaking ice have failed to make a passage. The increased traffic caused the owners to put the *City of Chester* in service this winter also, and by the middle of March they expect to have the new vessels, the *City of Philadelphia* and the *City of Wilmington* in commission. These new boats, like the older vessels, were built by the Harlan & Hollingsworth Corporation, of Wilmington, Del., who have had wide experience in this class of work. The new vessels have more powerful and heavier machinery, more freeboard, considerable more steel in their superstructures, and carry a larger load of passengers and freight, all this calling for more displacement, and, as the length was limited on account of turning in the Christiana River, a carefully designed vessel was necessary to fulfill all conditions imposed.

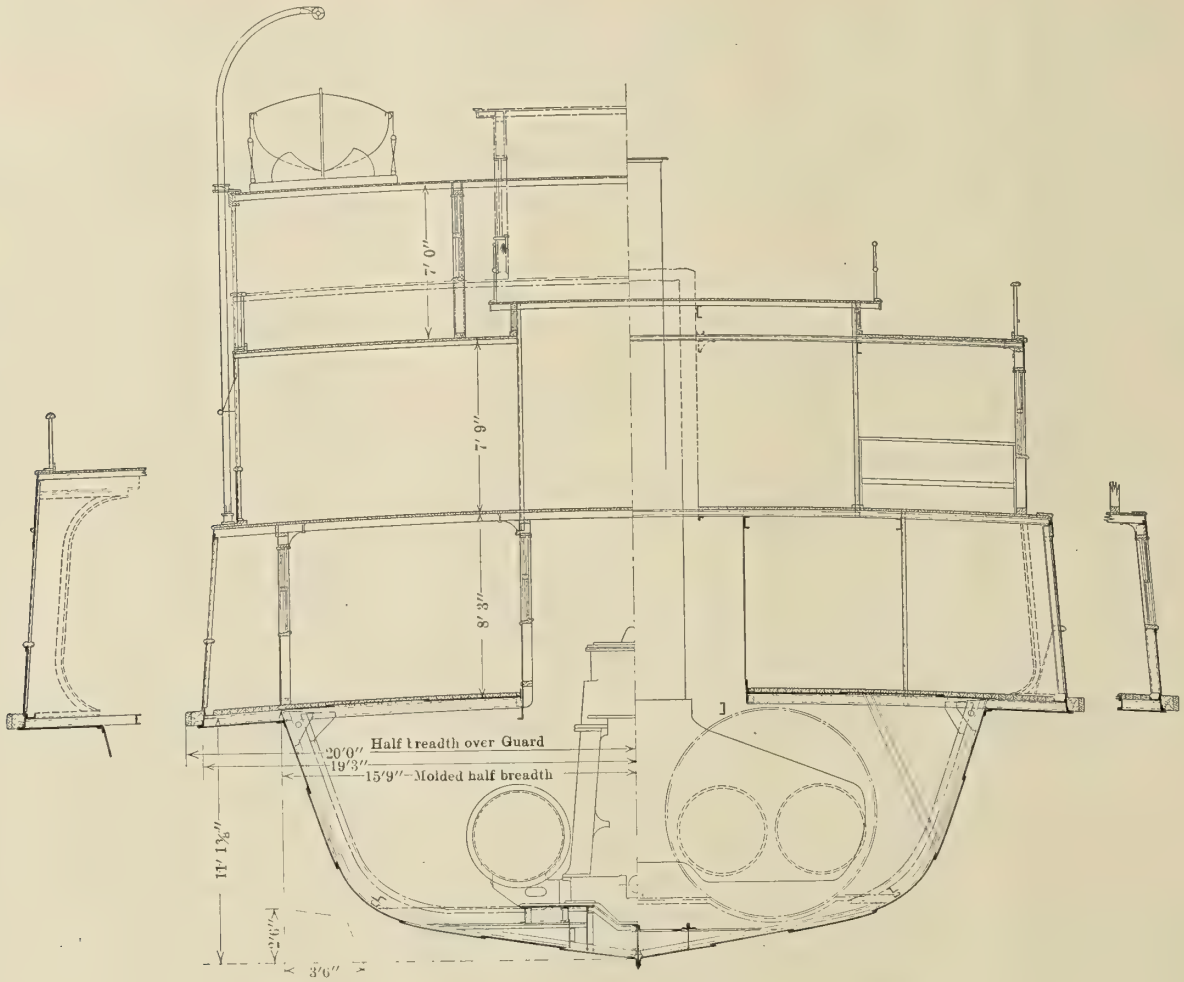


ONE OF THE NEW WILSON LINE STEAMERS READY FOR LAUNCHING AT THE YARDS OF HARLAN & HOLLINGSWORTH, WILMINGTON, DEL.

HULL.

The vessels are of the following dimensions: Length over all, 204 feet; length between perpendiculars, 186 feet; beam at deck, 31 feet; beam over guards, 40 feet; depth molded, 11 feet 4 inches. The hull is of steel, the heaviest plates being 25 pounds, and the lightest 5 pounds. The stern frame and rudder are solid steel castings. The frames are of angle section 6.6 pounds, having reverse bars in the machinery space. Bulkheads, belt frames and keelsons are fitted for stiffening the structure, the frames merely stiffening the shell. The deck beams are of Z-section, 11 pounds per foot, and are sup-

ported by girders and channel stanchions. The greater part of the main deck is covered with steel plating, as is the underside of the overhanging beams forming the guard, and there are no obstructions outside the shell, such as guard braces or brackets. The vessel is divided transversely by six watertight bulkheads, two of which have watertight doors. The engine seating is strongly constructed, of exceptional length, and is worked into the structure of the vessel. The freight enclosure is built of steel plates from 5 pounds to 3½ pounds. The ladies' cabin and upper saloon, stairways, etc., are of a composite construction to decrease the weight which would result from an entire steel construction. Light iron is used for panel work. The main deck is sheathed with rift grain Oregon pine, the fender outside the guard is of oak. The upper decks are of wood, as are the carlins, but they are supported by steel girders and steel pillars, which do not step on any combustible deck, but are carried down to the hull of the vessel. The builders hope to eliminate vibration (felt in the older vessels in shallow water) in these new lighter, but more rigidly constructed, vessels, where every part is contributing to the general strength of the structure.

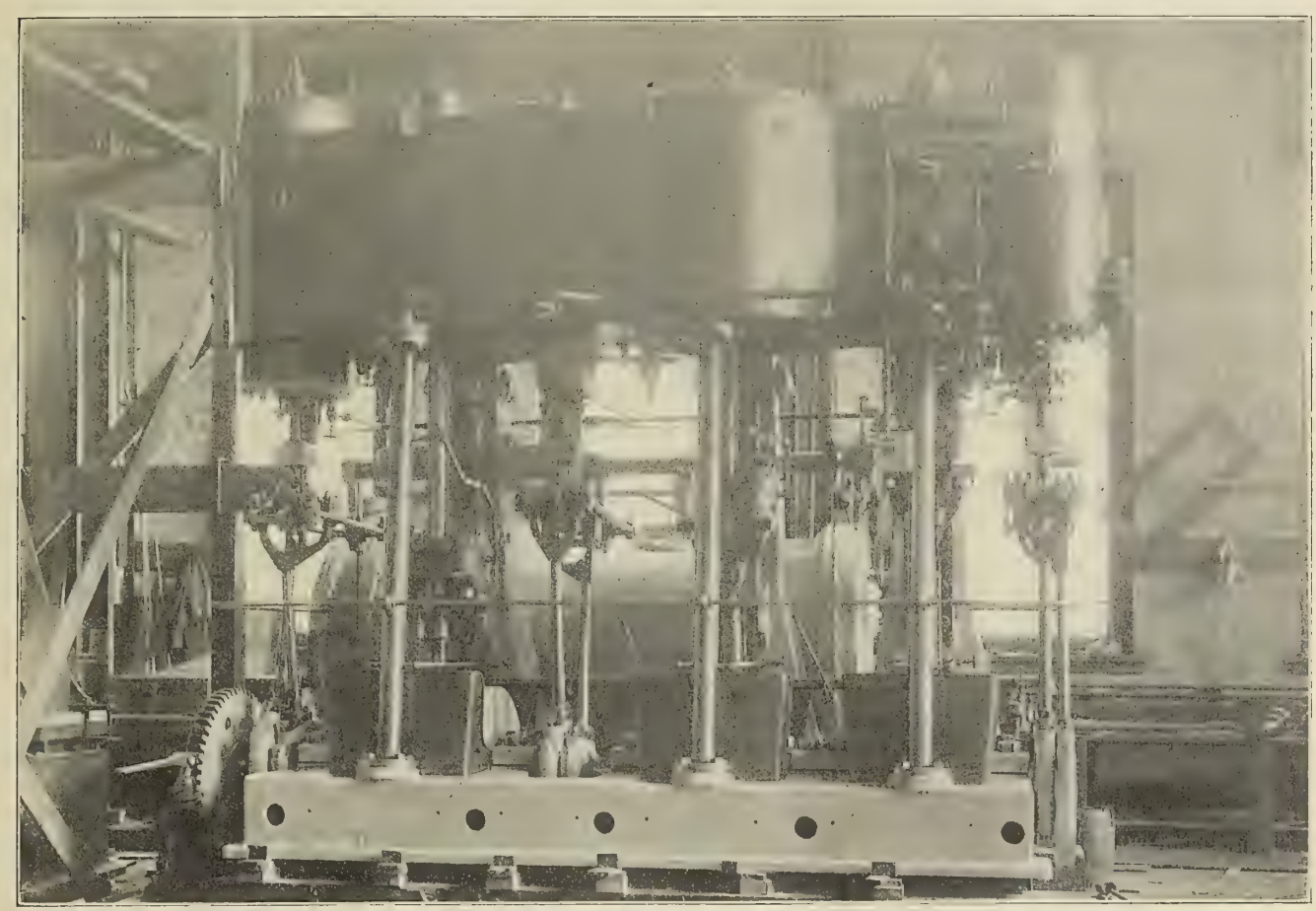


MIDSHIP SECTION OF THE CITY OF PHILADELPHIA AND CITY OF WILMINGTON.

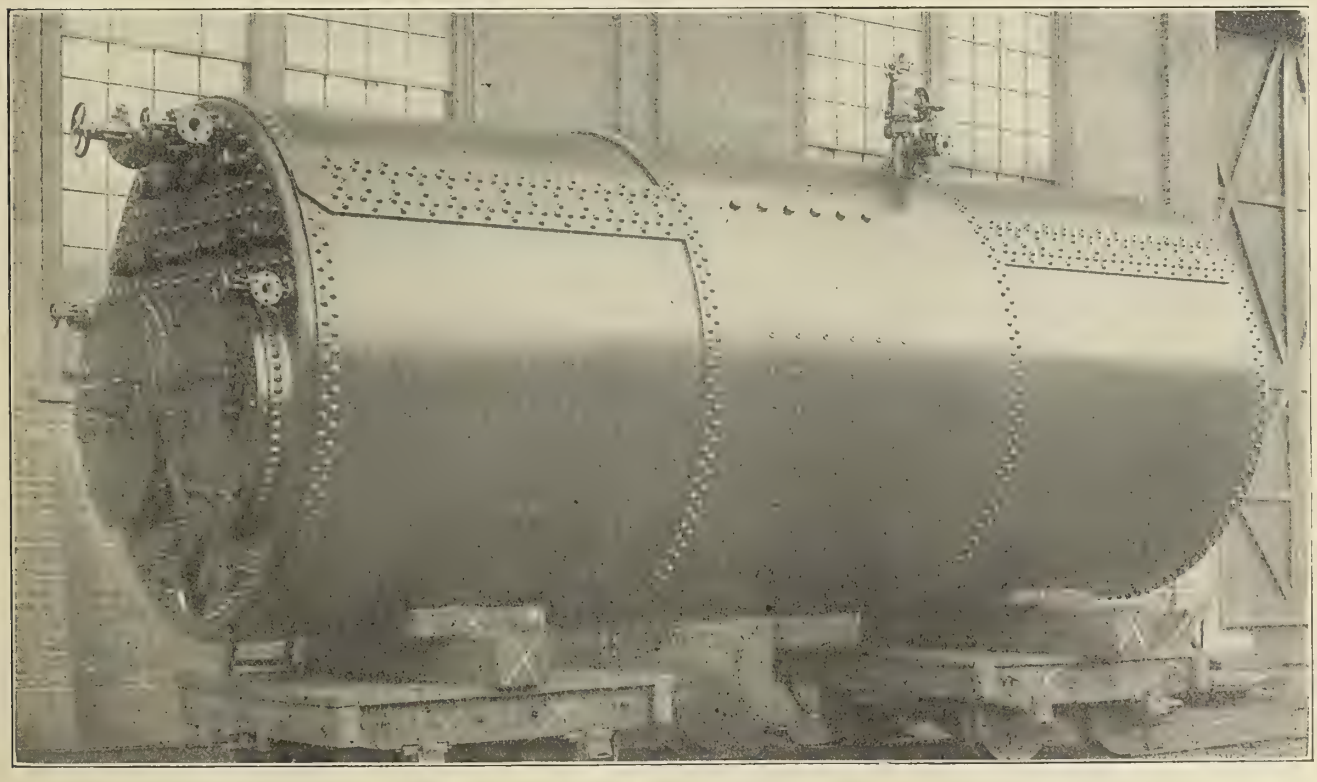
GENERAL ARRANGEMENT.

The general arrangement of the vessel can be seen from the accompanying plan. Below the main deck forward is the lamp room and chain locker in the fore peak; abaft this are the crew's quarters, fitted up with metal beds, metal lockers and wash bowls with running water. Between the forward boiler room bulkhead and the steel bulkhead abaft, the crew's quarters, the kitchen, messrooms, and store rooms are located. The ice is taken in through a deck hatch, river and city water is led to the kitchen sink. Abaft the boiler room is the coal bunker, coal being taken in through rectangular hatches made to take a specially designed coaling barrow. Abaft the engine room is a space which may be used for a lower cabin or café. The quadrant is fitted to the rudder stock under the main deck.

On the main deck the entire space from the stem to the engine hatch is reserved for freight. The forward part of the deck, outside of the freight enclosure is covered over by the saloon deck, which is raised to the height of the saloon rail, and allows large furniture vans to be taken on board. The stanchions are widely spaced for this purpose, and by means of weather screens this place can be kept proof against wind and weather. Opposite the engine hatch on the port side is the baggage room, and on the other side the men's toilet. The social or entrance hall extends the full width of the vessel, the paneling here is of metal, the pillaring and stairways are simple but massive in baronial design. At the fore end of the hall, on the port side, the oyster bar is located, while the confection and cigar stand is on the starboard side. The captain's room, ticket office, purser's room and wireless telegraph office are situated at the aft end of the hall, with an entrance to the ladies' saloon or retiring room. The paneling of the room is in composite board, the floor is carpeted, the seats are upholstered in leather; pantasote shades of the railroad type



PROPULSION IS BY MEANS OF A SINGLE SET OF THREE-CYLINDER, TRIPLE-EXPANSION, SURFACE CONDENSING ENGINES.



EACH VESSEL IS FITTED WITH TWO GUNBOAT BOILERS; DIAMETER, 9 FEET 4 INCHES; LENGTH, 22 FEET; WORKING PRESSURE, 180 POUNDS PER SQUARE INCH.

are fitted in the windows; lockers, folding bed, and mirrors are provided, and immediately abaft is a large and airy toilet having a tiled floor and the most improved sanitary fittings. The stairways from the main to the saloon deck land in enclosed spaces and are protected from the weather, something which is not always found in vessels of this type.

The forward part of the saloon deck is raised to the height of the saloon deck rail, and forms a very airy space for passengers desiring a good view, fresh air and sunshine. The space between this and the saloon proper is covered over by the hurricane deck, and is sheltered from rain and sun by a side visor. The saloon proper is a large steel enclosure, having steel paneled walls. The floor will be carpeted; desks, chairs, and a news or stationery stand will be located in this cabin for the comfort and convenience of passengers. Hardwood seats are arranged as in a Pullman car. The windows are arranged in groups of three and are built to open similarly to a house window, each window is provided with a pantasote shade sliding in grooves as on a railroad car. This saloon is surmounted by a central coach roof skylight, which affords ventilation and central light. The design and finish of this saloon are similar to the social hall, but lighter in character. The casings from the boiler room, stokehole and engine room passing through the saloon are all of steel. The space abaft the saloon is a covered promenade, lit in the center by a coach roof extension, and has a side visor fitted all round.

There are two stairways from the saloon to the hurricane deck; the after stairway is protected by an awning, while the forward stair lands in a hallway in the officers' deck house. The pilot house is raised above the level of the remainder of this deck house, and has a navigating bridge carried at the level of its floor out to the sides of the ship. The usual steering, navigating and controlling appliances are installed. Abaft of the pilot house is the hallway and rooms for officers, all of which are fitted with metal beds. The remainder of the space on this deck and on top of the coach roof, which is railed in, is devoted to a passengers' promenade; two of the lifeboats being stowed on this deck. The whole space from the house aft is covered and protected by an awning carried on a metal framework. The top of the officers' house extends to the side of the vessel and forms a shade and deck for the remainder of the lifeboats.

The rail and awning stanchions throughout these vessels are of metal. The deck machinery consists of a combined hand and steam steering engine of Williamson Bros.' make, located in the engine room and controlled from the pilot house in the usual manner. A hand capstan by the same maker is fitted forward, also an anchor crane for operating the anchor and chain. The vessel is lit by electricity generated by two General Electric direct-connected marine sets, having sufficient power to operate a powerful searchlight and the wireless telegraph system. The searchlight is placed on a platform in front of the mast and controlled from within the pilot house. The aerial for the wireless apparatus will be strung between the smoke funnel and the ensign staff aft. All wiring is in conduit, and the fixtures are of a neat design in harmony with the finish of the cabins. The vessel is heated by steam, and ice water is provided and led to drinking alcoves or fountains located where most convenient for the passengers' use.

MACHINERY.

Each vessel is fitted with two boilers of the straight through or gunboat type, 9 feet 4 inches diameter by 22 feet long, constructed for a working pressure of 180 pounds per square inch. Each boiler will contain 2,100 square feet of heating surface and 47½ square feet of grate surface.

Propulsion is by means of one set of engines of the triple-expansion, surface-condensing type, having three cylinders working upon three cranks set at angles of 120 degrees. The diameter of the cylinders are high-pressure 19 inches, intermediate 29 inches, low-pressure 44 inches, having a common stroke of 24 inches. They are designed to run at about 160 revolutions per minute in service conditions.

The cylinders are arranged with the low-pressure in the middle, and cranks are fitted with balance weights, with a view to reducing the vibration to a minimum. They are supported upon three cast iron box columns at the back, and three polished mild steel columns in front. The high and intermediate cylinders are fitted with piston valves, and the low-pressure cylinder has the ordinary double-ported slide valve. These valves are actuated by the Stephenson type link motion, all parts of which are made very heavy for the extra duty imposed by the special service in which these boats are engaged. The reversing of the engine is done by a vertical steam cylinder automatically governed by eccentric and levers on the reversing shaft.

The pistons are of cast steel, designed so that the weights will be as nearly equal as possible. The guides for the piston rods are of the bar or locomotive type, cast hollow, with water circulating through them. The connecting rods have forked upper ends, with two bearings for attachment to the crosshead. The crankpin boxes are of cast steel; these and the main bearing boxes are fitted with slabs of phosphor bronze, a type of bearing which has been successfully used by the owners of these vessels for a considerable number of years. The thrust bearing is of the ordinary horseshoe type, having five collars for going ahead and three for backing, each faced with anti-friction metal.

The propeller wheel is of the solid type of cast steel, having four blades, 8 feet 6 inches diameter; this is held on to the shaft by a steel feather and wrought iron nut.

The condenser is independent of the main engine, being circular, constructed of steel plates, and containing about 1,925 square feet of condensing surface. All the pumps are independent, the air pump being of the vertical twin-beam type, having two steam cylinders and two water cylinders. The feed pumps are in duplicate, of the vertical simplex type, each capable of supplying the boilers with water under normal conditions. The bilge pump is a horizontal duplex, having steam cylinders 4½ inches diameter, water cylinders 6 inches diameter by 6-inch stroke. The circulating pump is of the centrifugal double-suction type, having large suction to the bilges for use in case of leaks. There is also one sanitary salt-water pump of the horizontal duplex type, and a large donkey and fire pump located on the main deck connected up ready for instant service.

There is one smokestack common to the two boilers; this is fitted with an outside air casing, having large intervening space for ventilation. The stack is fitted with a steam jet of the Bloomsburg latest improved type, which is expected to add materially to the steaming capacity of the boilers.

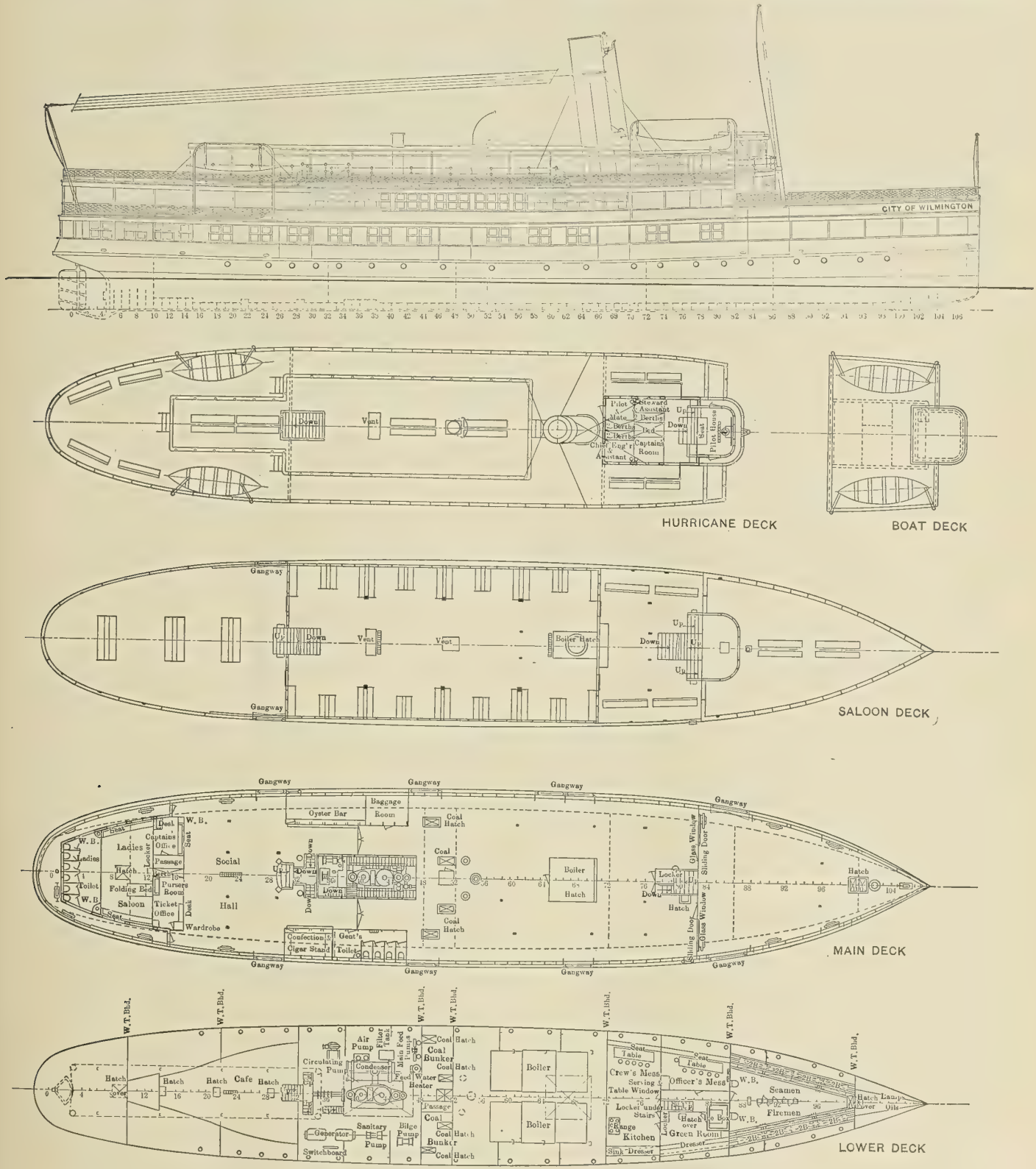
The main steam pipes, where practicable, are made of steel, the remaining part is of copper, with specially designed bends, to allow for the expansion. A feed-water heater of the multicoil type is fitted between the feed pumps and the boilers. All other details of the latest design have been installed in these vessels, so as to bring them in line with the latest practice in vessels of this class.

Trial Trip of a New Steamer.

On Feb. 15 the steamship *Bradford City,* built by Messrs. Ropner & Sons, Ltd., of Stockton-on-Tees, made her official trial trip in the Tees Bay. The steamer has been built to the order of Messrs. W. R. Smith & Son, Cardiff, and is classed to the highest class in the British Corporation Registry.

She is 358 feet 6 inches in length, and has a dead-weight carrying capacity of about 6,300 tons. Her outfit is thoroughly up to date, and includes stockless anchors, a quick-warping steam windlass, steam steering gear amidships, and powerful screw gear aft, while she is particularly well equipped with derricks and winches of the most modern type, in order to facilitate the loading and discharging of cargoes. The accommodation for the captain, officers and engineers is in houses on the bridge deck, and for the crew in the forecastle.

Propulsion is by means of triple-expansion engines, built by the North Eastern Marine Engineering Company, Ltd., Sunderland, which, it is reported, have worked very satisfactorily. After some very satisfactory trial runs, during which the vessel attained a speed of over 11 knots, she proceeded on her run round to Cardiff, her loading port.



OUTBOARD PROFILE AND DECK PLANS OF THE NEW WILSON LINERS.

MACHINERY AND PIPING ARRANGEMENTS—V.*

BY JOHN M'COLL.

As it is usually in connection with the ballast and bilge systems that the engineers can commence work on a ship, it is advisable to have this part of the work in hand, and the drawings, sketches and prints sent out to the shops as soon as possible. It will be an advantage in most cases to tint the leads of piping in the arrangement prints sent to the fitting-out department; it can be easily and quckly done in the drawing office, and will save time in the other department. The prints should be of cloth or linen, as paper, either thin or thick, will not stand the handling and wear to which it would be subjected in the ordinary course of the work. As previously stated, the drawings need not form part of or be embodied in the main drawing; they are better kept separate, especially in medium-sized and large ships. The drawings required are a plan, elevation and sections; of course the number of sections and partial views will depend upon whether the job requires minute detailing or not. If a framed print is to be supplied for the engineers of the ship, this should be considered when grouping the different views, so that they may be contained within reasonable limits. The scale to which the drawings are made for small vessels is usually ½ inch to the foot, and for the larger ships ¼ inch to the foot.

The pipes and fittings for the ballast and bilge steam service extend the whole length of the ship, except in the fore peak, which is fitted with a hand-pump suction only, and an agreement generally must be made between the shipbuilders and engineers regarding the share of the work each will do. The usual demarcation is, that the engineers do all pipes and fittings inside the forward and the aft bulkheads of the machinery space, including the thrust recess and tunnel, if that is used as part of the engine room, and the shipbuilders do all pipes, etc., outside of and up to these bulkheads, supplying and fitting also all hand pumps as required on deck.

The number, size and position of the bilge steam suctions in a ship will depend on the rules issued by the society with which the ship is classed, as Lloyd's, British Corporation, etc. The deck hand-pump suctions are fitted according to the Board of Trade rules in Great Britain. These suctions are to be considered in size and number as the minimum, and may with advantage be increased. This is sometimes done, especially in the machinery space, where the owners may think it advisable to add to the number of connections, on account of obstructions to the easy draining of the bilge water, to the point where the suction pipes are located.

Generally the suctions are placed at the after end of the compartments from which they draw, but in a ship with fine after-body, they may be better placed at the forward end of the compartment in that part of the ship. In other words, they should be placed at a point to which the water will probably drain. In vessels where the tanks are carried flat to the ship's side, or in recesses and passages where the water cannot escape to the ship's side, depressions or shallow wells are made in the tank top. These are made sufficiently deep for the water to collect there and insure the pumps drawing properly.

The usual procedure followed in connection with ballast and bilge arrangements is, that the shipbuilders make out in diagram form the arrangement for the whole ship, getting from the engineers their proposals for the machinery space. This is sent for approval to the surveyor of the society with which the ship is registered, and in every case to the Board of Trade for their approval. The shipbuilders may send only their part early for approval, leaving the engineers to submit theirs separately, when finally arranged.

An important point to be considered in fixing the position of bilge suctions, is that the rose boxes should be readily accessible for cleaning. Some ships with double bottoms, all fore and aft, do not carry water ballast in that part under the boilers, but one or more bilge suctions will be required there, and these should be placed so that they can be easily reached from the nearest tank top manhole. The same consideration ought to be given to placing the ballast tank suctions. One or two frame spaces forward or aft will make little or no difference in the efficient pumping out of the tank, while it may save the ship's engineers from having to get through a maze of holes in floors, under conditions which are very different from those obtaining when the ship is in dock.

It may be stated that all ballast tank valves are made to lift with the spindle, and all bilge valves are of the non-return type. All bilge suction pipes have rose boxes fitted at their ends, but with tank suctions these are not required. Each bilge suction should be provided with a mud box in addition to the rose box, and the water should pass through the mud box before going through the valve. This arrangement will admit of the mud box being cleaned out while the other suctions are being used. The pipe from the box should, if possible, be straight, as shown in Fig. 20, so that it would be easy

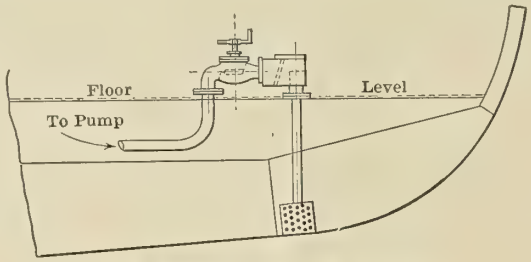


FIG. 20.—BILGE VALVE AND MUDBOX.

to clear if it became stopped. All these requirements can seldom be allowed for together in the same job, and, as in arrangement work generally, compromises very often have to be made.

The position of the valve chests or groups of valves in the stokehold and engine room will naturally depend on such things as the position of bunker doors, bulkhead stiffeners, ladders, wide or narrow passages or stokeholds, and the height of the platform. In the engine room there is seldom much room for choice, and the guiding requirement might be stated as, that both ballast and bilge-valve chests should be placed where they can easily be reached for working—the bilge boxes especially for cleaning—and all where the length of piping for connecting up will be the shortest.

With regard to the number of valves that may be grouped in one ballast chest there is no definite rule. It is often better to have two or three small independent chests placed near their work than one large chest with the pipes stretching across the tank and crowding together at the valves. It may be better economically, and, what is more important, it will lessen the risk of failure of the whole system if one valve or chest should require overhauling.

The form of valve most common is the ordinary miter-faced type, with brass seat. Another type used consists mainly of a rubber disk, suitably held on the spindle. The latter has some advantages, but does not wear very well. Tell-tale pipes to indicate when each tank is full are sometimes fitted to the chest. These are small wrought-iron pipes about 1 inch bore, screwed into a boss below each valve and carried up the side of the bulkhead to a little below the level of the light load line.

* Concluded from the February issue.

The size of the outlet branch from a chest, with two or more valves, need not be greater than that of the largest suction, and if suitable the branch should be turned down in line with the inlet branches. The height of the chest from the tank top should not be more than will give room for easy bends in the pipes to and from it (as the more nearly the pipes are kept in one plane, the less the work that is put on the pump), but for convenience they are usually arranged with the lower pipe flange in line with the platform. In the stokehold the valve chest should be well guarded round with fender plates, so as to keep them from injury and dirt. In special cases these fender boxes are fitted with padlocks and so subdivided that each wheel is under the control of the engineers only.

In ships with deep ballast tanks special arrangements have to be made. Unlike the ordinary ballast tanks, they cannot be filled by simply letting the water run in; they require to have the water pumped in after the outside water level is reached. This pumping up should be done through a separate discharge pipe from the ballast pump direct to the tank. If it is done through the main system pipes, these are subjected to undue pressure, which may result in leaks or breakage. These tanks are used as ordinary cargo holds when possible; and as there is the possibility of water getting through to the cargo when filling the other tanks, extra precautions are taken to prevent this. A simple device is that shown in Fig. 21.

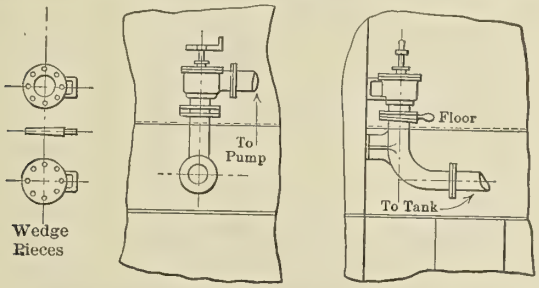


FIG. 21.—ISOLATING ARRANGEMENT FOR DEEP TANKS.

Here wedge-shaped pieces are made to fit between the chest and a cast-iron bend or pipe. One piece is made as a ring, and fitted when the tank is used as a ballast tank, to be taken out and replaced by a blank wedge piece when the tank is used as a cargo hold. The piece not in use is either stowed immediately above the chest or kept in the engineer's room.

The suctions from the deep tank should be as large as possible; that is as large as the main pipe, and if the tank extends the full width of the ship, a small suction should be fitted at each side so that it may be well drained. These suctions should also have the wedge pieces or other isolating arrangement. With regard to the pipes and fittings for deep tanks, it should be remembered that the extra head of water will put extra pressure on these, and it may be necessary to make allowance for this accordingly.

The diameter of the ballast main pipe will depend much on the time to be allowed for filling and emptying the tanks. The capacity of the ballast pump will probably be based on that requirement, so that the bore of the suction opening on the pump may be taken as approximately the bore of the main pipe. In some ships having to sail for part of their voyage in shallow waters the tanks may be required to be emptied at very short notice, then advantage is taken of the full capacity of the pump. In other ships, where more time can be taken, one tank at a time is filled or emptied; in that case the combined areas of the suctions from the largest tank may be taken as the area of the main pipe.

Suction pipes on their way to the valve boxes should not pass through other tanks, as in the event of pipes becoming leaky or damaged, it is not easy to decide which tank is being drawn from, or filled, or to locate where the defect lies. Various difficulties may be caused through the pipes being arranged that way, and in most cases it is better to have the pipes carried along the tank top or at the ship's side. The length of cast iron pipes in the ballast system should not exceed 9 feet, and long runs of these should not be bolted together without introducing at some part bends of flexible material. Lead is the material most commonly used for bends, and it is suitable up to 6 inches bore, above that it is advisable to use copper. In first-class work galvanized iron is used for bends, and it certainly is better in many respects than lead for that purpose.

The suction pipes projecting into the tanks are carried down to within a quarter of the diameter of the pipe from the bottom of the tank. Some of these pipes of large diameter are made bell-shaped at the end, and may be carried still closer to the tank bottom, provided the area past the edge is equal to the area of the pipe.

If the sea inlet valve for the ballast tank is to be used for that purpose only, it will be at least the same diameter as the main; but if it is to serve also as the sea suction valve for the ballast pump, it may require to be made larger than the main. The suction connections of the ballast pump are usually from the sea, ballast tanks, bilge system and bilge direct. These are sometimes grouped in one box and bolted to the pump. The point to be observed in this arrangement is, that when the tanks are being run up, the water should not cover the bilge valves, as otherwise the pump has to stand idle till the tanks are filled. The box can easily be made to suit this requirement and should be so made if at all convenient.

The ballast pump suction from the bilge direct should be larger than the ordinary bilge suctions, and in large ships it may be advisable to fit one at each side of the engine room.

When there are two or more pumps drawing from the bilge system, it is good policy to divide the system into two sections—forward and aft—by fitting a straight through cock in the main. An equal number of pumps are put on each section, and each can draw from any part of the system when the cock is open, but should any section, say the forward one, be disabled, the cock is shut and the after section is not affected, or, of course, the aft division may be damaged without involving the forward part.

The arrangement and details of the ballast system piping will apply generally to those for the bilge system, and the thickness of the cast iron, and wrought iron, or weight of the lead pipes will conform to the owners' requirements, or to the builder's standard practice.

SCHOOLS OF MARINE ENGINEERING AND NAVIGATION IN CONTINENTAL EUROPE.

BY W. H. DOOLEY.*

Very few people realize how far behind other countries the United States is in her facilities for the education of marine engineers and navigators. In this country we believe in educating at public expense young men who are going into the professions, but nothing is done towards helping the young tradesman to advance in his craft. This is particularly true in the marine branches.

No country spends the amount of money for marine education that the little country of Holland has seen fit to do. Of course, Holland is distinctly a commercial country. Her numerous ports and excellent docks place her among the leading commercial nations of the world. The chambers of commerce of her cities are "live" bodies and are constantly bring-

* Principal Lawrence (Mass.) Industrial School.

ing before the world the advantages of Holland as a commercial nation.

As early as 1878 the progressive shipowners of Holland established a school for educating engineers exclusively for sea duty. This was established in Amsterdam and was built to meet a distinct educational need in the marine service, to insure proper training for engineers. The school has long since proved its worth. Since this school has been founded there has been less damage, due to incompetent engineers.

Similar in aim to the training school for marine engineers is the old school, renowned in the Netherlands, and known as the training school for the merchant marine. The aim of this school is to train officers for the Dutch marine. Not all boys with an inclination for sea duty are able to avail themselves of the expensive training supplied by the marine service school. For such as are unable, a cheaper course is provided in the nautical school. There are altogether eleven of these schools, and three schools for fishery, with sixty-three teachers and 590 pupils. With the exception of the oldest school at Amsterdam, they are supported by State, provincial and municipal subsidies, and by private donations. Some of these schools are free, others charge a very small fee.

Examinations for masters' and mates' certificates, similar to those of the Board of Trade in England, are held ten times a year alternately at Amsterdam and Rotterdam by a commission appointed by the Ministry of Waterways, Trade and Commerce; candidates must be eighteen years of age, and in addition to the technical subjects, they are examined in English, French and German.

The school at Rotterdam is next door to the Seaman's Home in the Westhaven, and the director, E. J. Hoos, is always happy to show one through. Lads, in order to enter, must not be less than fourteen or more than seventeen years of age on entering. The practical instruction during the first year is given chiefly by an old boatswain. The garden has a rigged mast with yards and sails, and a boat for rowing, etc. Later, the instruction is given by a former captain in the merchant service. The classes in steam engineering and the construction of ships, etc., are taken by a retired naval officer, who was at one time instructor at the Royal Naval Institute. An ample supply of good models and drawings has been provided by the manufacturers, and there is an engine from one of the demolished torpedo boats. Pupils have full access to the engine and shipbuilding wharves, the drydocks, and can go on board the mail steamers. From time to time they are taught how to handle engines on boats going down to the Hook. The number of pupils in the two years' course is fourteen, and of those in the special classes, ninety-nine, the average attendance of the latter being about thirty-three a month.

Since the opening of the fisher's harbor at Ymuiden in 1896, that port has been the principal fishing center of the Continent. In the year 1908 over $2,000,000 (£410,700) worth of fish was sold in the fish market of the town. This was largely exported in daily shipments to foreign countries by rail in a fresh state. In view of the importance of this industry a school was started in 1906 at Ymuiden with the idea of obtaining in the future a staff of thoroughly trained captains and mates for sailing and steam fishing boats. Although the school has been in operation for only two years and a half, the results obtained are very satisfactory.

Every Dutch boy who has passed successfully the physical examination and can show a report of good character from the public school which he attended can obtain permission to enter the school, which is divided into three classes.

The first class, the work of which covers a period of one year, starts in November, and is for boys just leaving school, between thirteen and sixteen years of age, who are taught arithmetic, geometry, the Dutch and English languages, shipbuilding, geography, practical and theoretical navigation, laws of navigation, steam mechanics, refitting of vessels, first aid in case of accidents, making and repairing sails, nets, etc. The theoretical work is done on shore in the schoolroom; the practical part on board the instruction vessel in the fishing harbor of Ymuiden, and on board a sailing vessel called the *Ymuiden,* which puts out to sea from February to October.

From November until February the boys remain on shore; afterwards they are sent to sea in the fishing vessel, five boys at a time, for eight days, and so on till October. During their stay in the harbor the boys sleep on board the instruction vessel, so that they may become accustomed to life on board ship. This instruction vessel is fitted out for ten boys, and is under the supervision of a captain and his wife; the captain gives practical lessons in repairing, refitting, etc. The boys have 40 hours class work a week, of which 14 hours are practical work. After the first year they can obtain a certificate from the board of directors, who find employment for them on board sailing vessels, so that they can learn fishing thoroughly and earn their own living. Their wages are about $10 (£2.05) per month. The board provides each boy with a whaling suit of cloth, shoes, etc., on entering the school, but the boys are obliged later to refund the money out of their own earnings, from which 20 percent is deducted and paid direct by the captain of the vessel on which the boy is serving to the board of directors. The cost of such an outfit is about $24 (£4.9) a boy.

After having spent three or four years at sea, the boys return to the school to prepare in the second class for the government examination for the certificate of mate of fishing vessels, which preparation occupies almost five months. After another year at sea they return for the last course of three months in the third class, which prepares them for the government examination to obtain their certificate of captain, so that in six years the whole course can be completed. In the last two classes they work 22 hours a week.

For the first course no fee is paid, but for the last two courses pupils have to pay $1 (£.02). If a pupil is not considered diligent, or if he goes to sea before having obtained a certificate from the board after the first year, he is immediately dismissed, and his parents or relatives are compelled to refund the money paid for his outfit. The society was started by voluntary contributions, and the government lent the two training vessels. In several other parts there are similar schools, but this is the only one in which lessons are given the whole year round. At the end of the first year twelve certificates were given to the pupils, for whom employment was found on the different fishing boats and trawlers of Ymuiden. The reports from the captains of these boats concerning the work of the pupils are satisfactory up to the present.

The Prussian government turned its attention to the establishment of schools of navigation as early as the beginning of the nineteenth century. One of the first of these schools is reported to have been organized at Danzig in 1817. The purpose of this institution was declared to be the education of competent sailors, pilots and captains. In the absence of an independent school building, and of sufficient funds to erect one, the new school had to content itself, for the time being, with four rooms of an old church. The course of study occupied two years and was eminently practical. In fact, in all its essentials the curriculum remains the same to-day.

In the course of the decades following the establishment of the school at Danzig, a number of similar institutions were founded elsewhere. By 1855 such schools had been organized at Memel, Pillaw, Gralow and Stralsund. The attendance at this time was 246, and by 1863 the number had been swelled to 304. More schools were soon added, for their value was

proved by the results of the old schools. In close succession there followed schools at Barth in 1865, and at Leer in 1866, and at Geestemünde in 1870.

It was deemed highly important to provide means whereby the young boy might start as early as possible the study of his profession, as it was claimed to be necessary to enter the seaman's profession at an early age, even at a sacrifice of part of the general education that might otherwise be obtained. For this reason preparatory schools were organized in connection with all the regular schools of navigation, while in some cases special preparatory schools were established independently. Experience has shown that many of the students who attend the preparatory schools drop out on completing the work without entering the regular schools. Among these are numbered students who are too poor to afford a higher education, as well as those who, from the start, are undecided as to just what profession they will enter.

The popularity and value of the schools of navigation are well shown by their wide distribution throughout Prussia. In 1902 institutions of this class were located at Pillaw, Danzig, Gralow, Stralsund, Barth, Altma, Flensburg, Apenrade, Geestemünde, Timmel, Leer and Papenburg. Each of these schools has a preparatory school connected with it, and similar preparatory schools have been established independently at Sunidemark and six other places.

The total attendance at the preparatory schools, including the independent ones and those associated with regular schools, was 828 in 1901. During the same year 472 pupils were enrolled at the regular schools, of whom 323 studied as pilots, and 39 as captains.

For admission into the schools of navigation the applicant must show familiarity with the German language; knowledge of the fundamentals of fractions, decimals, proportion, extraction of roots; knowledge of algebra and geometry, especially of triangles and circles; knowledge of the elements of political and nautical geography. The possession of these educational requirements is tested by an entrance examination.

The two years' course of study in schools of navigation includes the following branches: Arithmetic, plane geometry, stereometry, plane trigonometry, spherical trigonometry, mathematical geography, astronomy, drawing; description and use of logarithms, half-minute glasses, compasses, use of Mercator's charts; calculation of currents in the sea; calculation of time on board; calculations of distance; hydraulics; statics, wind, sails, and their manipulations, maneuvering and control of ships; shipbuilding; duties and obligations of captain to his men and his cargo, and in loading, clearing, and sailing, quarantine, stranding, salvage, etc. It is hardly necessary to call particular attention to the eminently practical character of this series of studies in preparing a boy for a career on the sea.

No examination is required for admission into the preparatory schools, and the curriculum with the hours of study per week is as follows: German 6, arithmetic 12, geometry 8, geography 4, drawing 2. This gives a total of 34 hours per week. In addition, 2 hours a week are generally devoted to a study of first aid to the injured, under the guidance of a man with a professional medical training.

In 1879 the German Emperor by special ordinance prescribed regulations for the holding of examinations for those who desired to enter the profession of naval engineer. While these regulations were not severe, but merely required the knowledge to insure competent service, it was found that the applicants as a body were utterly unqualified for the work. They came largely from the locksmith and fireman's trades, and proved poor recruits for the rapidly developing navy and merchant marine of the Empire.

The result was that two schools for naval engineering were established, one at Flensburg and one at Stettin in 1890. At Flensburg, naval machinists from the first to the fourth class were educated, and at Stettin only those from the second to the fourth class. The Flensburg school, therefore, offered the higher grade of instruction.

The work for machinists of the fourth, that is, of the lowest rank, involves the following studies: German, arithmetic, mechanical engineering, physics and technology. A total of 24 hours a week are devoted to these studies for the period of two months. Machinists of the third class study German, arithmetic, mechanical engineering, physics, technology and electrotechnics. The latter branch characterizes the third class. A total of 30 hours a week is devoted to these studies for a period of two months. Machinists of the second class study mechanical engineering, drawing, mechanics, physics, technology, electrotechnics, arithmetic, geometry, German and English. A total of 45 hours a week for a period of five months is devoted to these studies. The studies for the first class machinists are German, English, plane geometry, stereometry, arithmetic, trigonometry, mechanics, physics, chemistry, mechanical engineering and drawing. Forty-five hours a week are devoted to these branches for a period of five months.

A SMALL OFF-SHORE CRUISER.

BY STEPHEN P. M. TASKER.

The boat illustrated is a useful and sea-worthy 31-foot cruiser, suitable for bay and off-shore work. Motor boats of this free-board and construction, with a reliable engine and good ground and sea tackle, are almost unsinkable. They can keep at sea for three or four days at a time and offer fairly comfortable living accommodations for three.

There is 6-foot head room throughout, with suitable cooking and sanitary conveniences, with speed commensurate with low cost of operation, vibration, etc. The cost of such a boat, with a high-grade motor, varies from $1,000 (£206), where one builds the hull himself, to $2,000 (£412) when furnished by a builder.

The lines are fairly good for the designed speed, considering suitable buoyancy, and with a maximum amount of interior space for the length.

Commencing forward, there is a galvanized iron fresh-water tank containing about sixty-four gallons, built to suit the shape of the boat. The tank is contained in a watertight compartment. In a 12-inch locker on the aft side of the bulkhead there are shelves, hooks, etc., with a door opening from the owner's cabin. In this locker there is placed an oak towing bit embeded in the oak stem. The owner's cabin contains two 6-foot 6-inch berths, with large drawer and locker space under, two side lights and several shelves. This cabin contains full head room, excepting at the forward end, and is well ventilated by a 6-inch ventilator, with copper cowl placed well forward, and a 2-foot skylight in the after end, thus affording good air circulation.

Aft of the cabin, on the port side, there is a heavily insulated icebox with dresser over, furnished with a galvanized iron sink, piped for fresh water from the forward tank. A two-burner yacht stove is supplied. A swinging shelf affords the necessary space for the preparation of meals. Above are the necessary dish racks, etc. Aft of the icebox is a 6-foot transom berth, with locker space under. On the starboard side forward is a 3-foot by 3-foot toilet, with patent water closet and wash basin. Aft of this compartment, by swinging up the companionway steps, the space can be utilized as a berth, with lockers under, making four berths in all. This compartment contains four side lights, a 6-inch ventilator

forward, a 3-foot skylight, two 12-inch by 14-inch windows, and a large companionway, affording ample ventilation. The trouble with most small cruisers is, that they are invariably very warm. No matter how well insulated the engine is, there is bound to be an accumulation of heat, and under a hot sun the boat becomes very stuffy. This is practically eliminated by the large amount of ventilation shown on these plans.

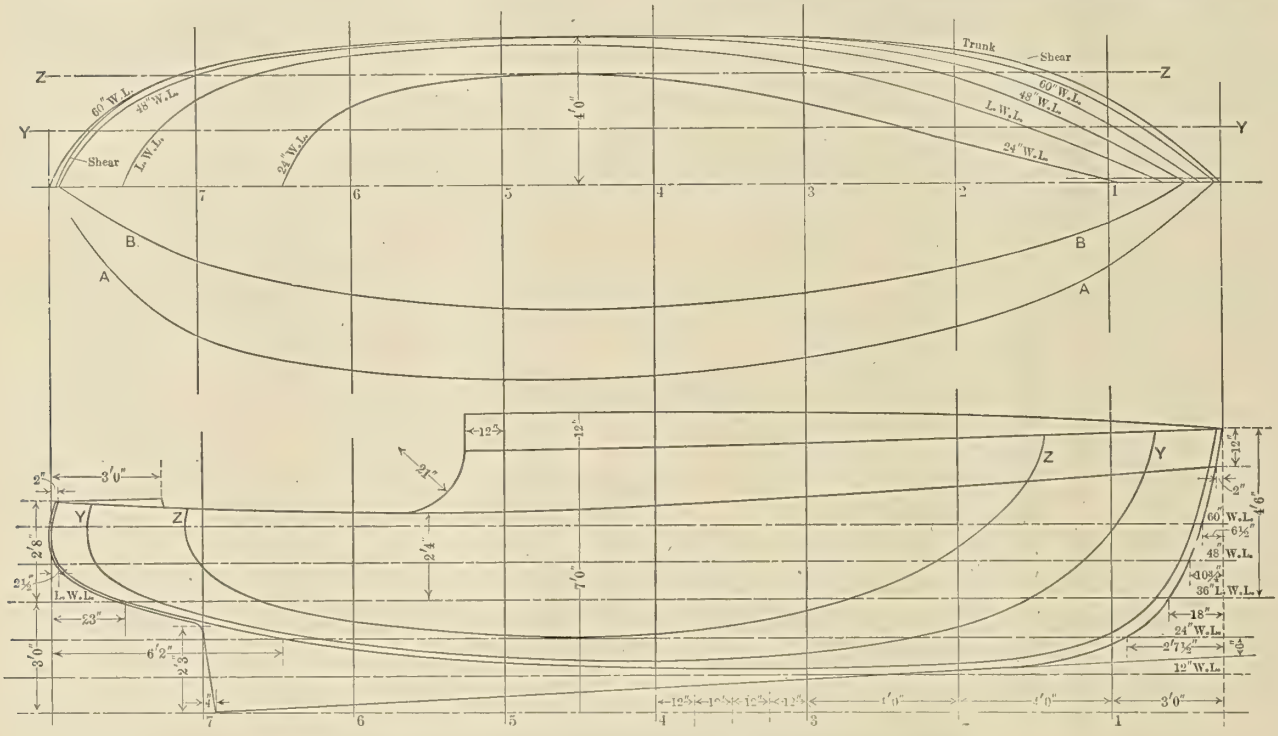
Another objection to the small boat is the vibration and noise of the high-speed motors usually installed. The motor most suited to these models is a heavy-duty slow-speed gasoline (petrol) or kerosene (paraffin) motor. The one shown in the plans is a 12 or 16-horsepower, heavy-duty, slow-speed, two-cylinder, four-cycle motor, of 6-inch bore and 7½-inch stroke, weighing, with reverse gear, 1,320 pounds. The horsepower from tests shows:

At 250 R. P. M.	12.61
At 300 R. P. M.	14.75
At 350 R. P. M.	16.66
At 400 R. P. M.	17.61

Consideration should be given the clutch on marine motors, as they have been a considerable source of trouble, and instead of the old-fashioned sliding key and expanding wedge for operating the wings of the clutch, there should be two arms riding up on a bobbin with all adjustment made from the outside. The gears for the reverse gear action should be made of the highest grade steel, bronze bushed. The spur gears are always in mesh and only in action on the reverse. The reverse band should be lined with Babbitt (giving an easy gripping action) and tightened by a worm screw.

Aft of the engine compartment there is a watertight cockpit, with large storage capacity underneath. The deck house is carried two frame spaces aft over the engine, to give plenty of head room and to facilitate overhaul. On the port side of the cockpit and in the recess made by this continuation of the deck house is the throttle lever, spark control, reverse lever and steering wheel. From this position the motor is visible, and the boat can be easily handled by one man.

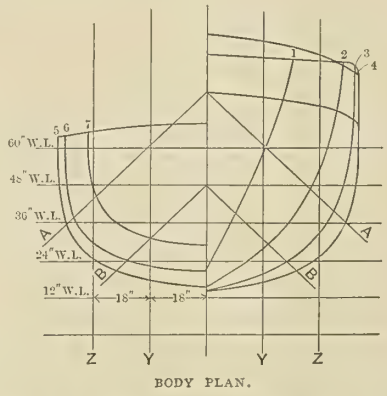
The cockpit contains comfortable seating capacity for the crew, with open or closed storage space under the seats. Aft of the cockpit is the fuel tank containing fifty-seven gallons of gasoline. Emergency gasoline tanks can be carried under the cockpit seats if they are desired.



WATER LINES, DIAGONALS AND BUTTOCKS OF A SMALL OFF-SHORE CRUISER.

The normal speed is 350 revolutions per minute and the minimum 100 revolutions per minute. The diameter of the crankshaft is 2¼ inches, and of the bronze propeller shaft 1½ inches. The propeller is a three-bladed manganese bronze wheel of 24-inch diameter and 30-inch pitch, the area is 209 square inches. The diameter of the exhaust pipe, which is water cooled, is 2 inches. The muffler is well insulated and is stowed under the cockpit. The ignition system is "make-and-break," with Bosch magneto, and is gear-driven, thus doing away with the unreliable dry cells. The motor is oiled by a mechanical force-feed lubricator, with ring oilers for the connecting rods, the same as government practice.

The circulating water inlet is 1-inch diameter, gasoline pipe ⅛ inch I. P. S. The air and circulating water pumps are the plunger pattern, and with a three-way sea cock attached, the bilges can be pumped out. The Schebler carburetor and the usual fittings and attachments consistent with the latest practice in gasoline (petrol) motor construction are furnished. The stuffing box and out-board bearings are of bronze, lined with Parson's white metal.



BODY PLAN.

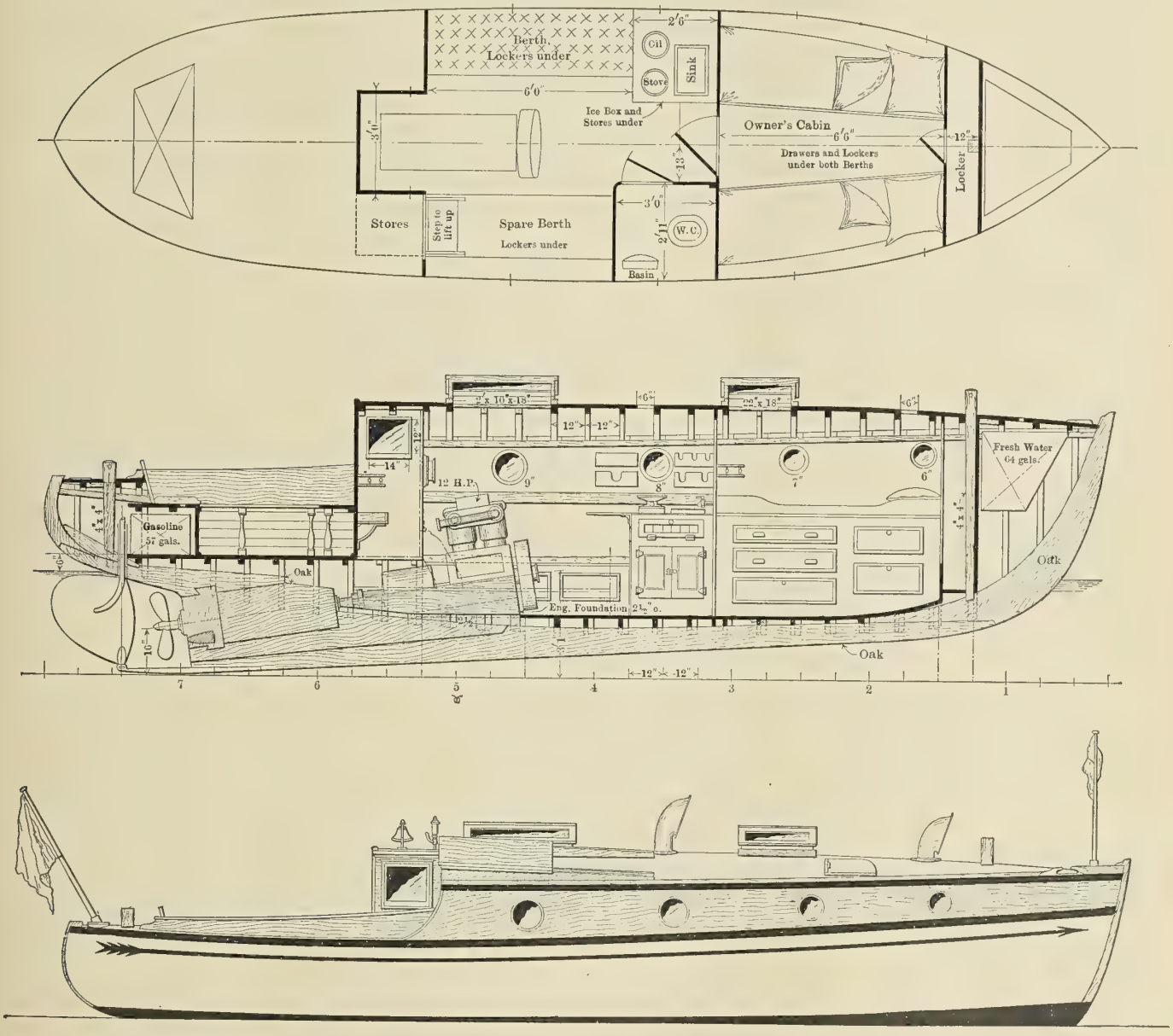
For certain conditions and waters it is preferable to use

kerosene (paraffin) in place of gasoline (petrol) for fuel. It can be procured where gasoline cannot and is considerably cheaper and theoretically more efficient. As it is a heavier fuel than gasoline it does not vaporize as readily. It is necessary to thoroughly vaporize it to secure proper combustion, and to prevent rapid fouling of valves, cylinders, piston rings, etc.; to do this the fuel must be heated. To accomplish this it is necessary to have a special casting, the inlet and exhaust manifolds being cast integral, the hot exhaust passing around inlet manifold, rendering vaporization complete. Sooting up of the interior of the inlet manifold, valve chambers, etc., is guarded against by special appliances in inlet manifold. The regular float-feed carburetor is used in making the mixture. It is, of course, necessary to heat the inlet manifold before starting on kerosene. This is accomplished by starting on gasoline and running for a few minutes, then switching over to kerosene. Only a small quantity of gasoline need be carried, and piping should be arranged with a three-way valve, so that one movement shuts off gasoline and turns on kerosene. This device has been thoroughly tried out in actual service, and a large number of working boats are now so equipped. As kerosene is a heavier fuel, the compression in a kerosene engine must necessarily be lower than that in a regular gasoline engine.

It is advisable to connect by belt or friction to the fly-wheel a small dynamo, with a 60-ampere hour storage battery for illumination purposes. There is enough energy generated during the operation of the engine to run the lights at night with the motor stopped, thus doing away with the danger of oil and matches.

For salt water the boat should be equipped with a bronze shoe and rudder.

This boat was designed by Tasker & Strawbridge, engineers and naval architects, Philadelphia, Pa.



GENERAL ARRANGEMENT OF SMALL OFF-SHORE CRUISER.

Trial Trip of the S. S. Benbrook.

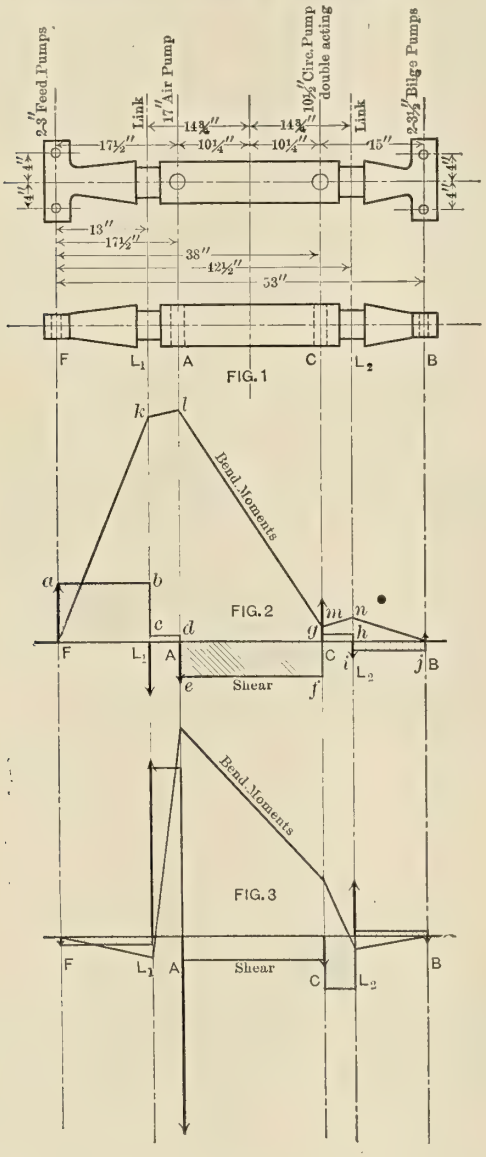
On Wednesday, Feb. 16, the finely modeled steel screw steamer *Benbrook*, built by Messrs. Craig, Taylor & Co., Ltd., Stockton-on-Tees, to the order of Joseph Hoult, Esq., of Liverpool, underwent her trial trip, which proved highly satisfactory in every way. The steamer will carry about 7,000 tons dead weight on a light draft of water, and the engines, which have been constructed by the North Eastern Marine Engineering Company, Ltd., Sunderland, gave her a speed of 10 knots loaded. On Feb. 24 the same firm launched the *Bengrove*, a sister ship of the *Benbrook*.

CALCULATIONS FOR THE SIZE OF A PUMP BEAM.

BY EDWARD M. BRAGG, S. B.

The stresses in the pump beam shown in Fig. 1 should be calculated for the worst condition, and in order that we may know the worst condition we must consider the action of the different pumps.

The total head upon any one of the pumps will be the resultant of the weight and inertia of the pump parts and water, friction, and the head, against which the pump is acting. Only that part of the water which is in the pump barrel need be considered when an air chamber is attached.



STRESS DIAGRAMS FOR PUMP BEAM.

The inertia is greatest at the beginning of the stroke, and upon the assumption of harmonic motion will be: $I = .00002837\ W\ r\ u^2$.

W = weight of plunger or piston, pump rod, and water in the cylinder. r is half the stroke of the pump in inches. u is the number of double strokes of pump per minute.

The friction F is not easy to determine, as it depends upon how hard the glands have been set up.

The head H against which the pumps are working will depend upon the suction head, discharge head, and the frictional loss in the pipes and valves.

In the case of the two 3-inch feed pumps, the weight and inertia of the parts will be small, compared with the head against which the pumps are working. The frictional resistance may be large, as the gland is fitted around the plunger and not around the rod. The up stroke is usually the suction stroke, and the water always comes to the pump under pressure and so does not have to be lifted. The maximum load on the pump rods will come at the beginning of the down-stroke and will equal $F + I + H - W$. The feed pumps usually have a relief valve attached to them to prevent the pressure in the feed line from becoming excessive when the supply pumped is in excess of the demand at the boilers. This relief valve is usually set at a pressure of about 20 pounds above the boiler pressure. The additional resistance, due to friction, inertia, and weight will probably be covered by an allowance of 20 pounds per square inch. This makes the total load upon the feed pumps $F + I + H - W = (180 + 20 + 20)\ 2\ \pi\ (1.5)^2 = 3{,}100$ pounds, approximately.

The load upon the bilge pumps will be comparatively small, and while they have to work against the suction head upon the up stroke, that will be small compared with the discharge head upon the down stroke. The discharge head will be approximately equal to the draft of the ship, and a sufficient allowance will be made for the other resistances if we take the total load as that due to twice this head. In this case we will assume the total head as 50 feet, and the load upon the two 3.5-inch bilge pumps will be $(50 \div 2.25)\ 2\ \pi\ (1.75)^2 = 425$ pounds, approximately.

The double-acting circulating pump will work against the greatest load at the beginning of the up stroke. This pump would have the least work to do when the ship is fully loaded, so that the overboard discharge from the condenser is but a foot or two above the waterline. If the pump suction is arranged to pump from the bilge in case of accident, this will be the condition for maximum load. The load at the beginning of the down stroke will be estimated, as that is the time when the other pumps have the most work to do, and the load for this pump will differ from the maximum only by the weight of the pump and the water in the cylinder. We will assume the total lift to be 25 feet; friction head of water to be 10 feet; inertia of pump and water to be equivalent to a pressure of 10 pounds per square inch; weight to be equal to 2 pounds per square inch, and friction of piston equivalent to 3 pounds per square inch of pump area. Total load $= [(25 + 10) \div 2.25 + 10 + 3 - 2]\ \pi\ (5.25)^2 = 2{,}300$ pounds, approximately.

As the air pump is single acting, it will always exert a downward pull upon the beam, except for a brief space of time towards the end of the down stroke, when the impact of the bucket on the water under it will cause an upward pressure. At the beginning of the up stroke the load will be due to the weight and inertia of the pump parts and water on the bucket and the friction. The pressure on the top and bottom of the bucket will be the same, and equal to the vacuum at that point. As the bucket rises, the pressure on the top increases and the load is probably a maximum when the water on the bucket strikes the underside of the discharge valve. At the beginning of the down stroke the load will be the resultant of the downward pressure, due to the vacuum of about 14 pounds, minus the inertia, equivalent to about 3 pounds per square inch; minus the friction, equal to about 3 pounds per square inch; plus the weight, equal to about 2 pounds per square inch of bucket area. The load will then be $(14 - 3 - 3 + 2)\ \pi\ (8.5)^2 = 2{,}270$ pounds, approximately.

In a case like this it is best to proceed as indicated by Fig. 2, where we have represented by heavy lines the loads just found for the different pumps. The distances between the pump rods are laid off to any convenient scale, and lines are drawn at these points, the direction of any line indicates

the direction of action of the load, and the length of the line is proportional to the amount of the load. The feed pumps are attached at F, the air pump at A, the circulating pump at C, and the bilge pumps at B. The links driving the beam are attached at L_1 and L_2, and the forces that these links exert must be such that their sum is equal to the total load from the pumps, and the moment of the resultant of the link forces is equal to the moment of the resultant of the pump forces about any chosen point of reference. In Fig. 2 we will take F as our reference point and find the resultant moment:

Pump.	Load, Pounds.	Arm, Inches.	Moment, Inch Pounds.
F.....	3,100	0.	0.
A.....	— 2,270	17.5	— 39,725
C.....	2,300	38.	87,400
B.....	425	53.	22,525
Total ...	3,555		70,200

L_1 is 13 inches from our point of reference, and L_2 is 42.5 inches.

$$\therefore L_1 + L_2 = -3{,}555, \text{ and } 13\,L_1 + 42.5\,L_2 = -70{,}200$$
$$13\,L_1 + 13.\ L_2 = -46{,}215$$
$$0 \quad + 29.5\,L_2 = -23{,}985$$
$$L_2 = -\ 813$$
$$L_1 = -\ 2{,}742$$

The shear on that part of the beam between F and L_1 will be 3,100 pounds. At L_1 the downward force of 2,742 pounds will reduce this shear to 358 pounds, which will be the shear on the beam from L_1 to A. At A the downward force of 2,270 pounds will cause the shear from A to C to be 1,912 pounds. At C the upward force of 2,300 pounds will cause a shear of 388 pounds on the part of the beam between C and L_2. Here the downward force of 813 pounds will give a shear of 425 pounds on the beam from L_2 to B.

The bending moment at any point will be the sum of the shearing forces between the end of the beam and that point. Starting from F the bending moment at L_1 will be

$$+ 3{,}100 \times 13 = + 40{,}300 \text{ foot-pounds.}$$

At A the bending moment will be

$$40{,}300 + 358 \times 4.5 = 41{,}910 \text{ foot-pounds.}$$

At C the bending moment will be

$$41{,}910 + (-\ 1{,}912 \times 20.5) = 2{,}714 \text{ foot-pounds.}$$

At L_2 the bending moment will be

$$2{,}714 + 388 \times 4.5 = 4{,}460 \text{ foot-pounds.}$$

At B the bending moment will be

$$4{,}460 + (-\ 425 \times 10.5) = -\ 2 \text{ foot-pounds.}$$

The bending moment at B should be 0, of course, and fails to be so here, because in getting the forces L_1 and L_2 we took the values to the nearest whole number instead of to the nearest tenth or hundredth.

The curve $F, a, b, c, d, e, f, g, h, i, j\ B$ is the shearing force curve, and the summation of this curve gives the bending moment curve F, k, l, m, n, B.

Before settling upon the sizes of the different parts of the rod from this curve of bending moments, it is advisable to see if the bending moment at some part may not be greater at some other point in the stroke.

The maximum stress will come upon the air-pump rod towards the end of the up stroke when the water on the top of the bucket strikes the under side of the delivery valves. We will assume that the pump rods for the air pump and circulating pump will be of the same size for the sake of convenience in carrying spares, and that at the middle they are 2½ inches diameter, and over the threads at the end are 2 inches in diameter. With a factor of safety of 13 for this size bolt, the working load could be 10,500 pounds. We will assume that in some way this load might come upon the air-pump rod and the loads on the other rods be the normal ones for that portion of the stroke. The feed pumps at this time will be drawing in water, and their load will be mainly that due to friction and weight. We will assume this resistance to be equal to 20 pounds per square inch. The load will then be $20 \times 2\,\pi\,(1.5)^2 = 280$ pounds, approximately.

The load upon the bilge pumps will be less than what we assumed before, because they are also drawing in water from the bilges. Assume the total load to be 200 pounds.

As we are assuming the pumps to have traveled about two-thirds of the up stroke, the inertia forces will be very small, so we will suppose the load on the circulating pump rod to be diminished by the amount allowed for inertia. This would make the load about 1,500 pounds.

Proceeding as before, with the loads as shown by Fig. 3, we obtain the values of the forces L_1 and L_2.

Pump.	Load, Pounds.	Arm, Inches.	Moment, Inch Pounds.
F.....	— 280	0.	0.
A.....	— 10,500	17.5	— 183,750
C.....	— 1,500	38.	— 57,000
B.....	— 200	53.	— 10,600
	— 12,480		— 251,350

$$L_1 + L_2 = + 12{,}480 \qquad 13\,L_1 + 42.5\,L_2 = + 251{,}350$$
$$13\,L_1 + 13.\ L_2 = + 162{,}240$$
$$0 \quad + 29.5\,L_2 = + 89{,}110$$
$$L_2 = 3{,}021 \text{ pounds}$$
$$L_1 = 9{,}459 \text{ pounds}$$

Shear at F = — 280 + 9,459

Shear at L_1 = + 9,179 — 10,500

Shear at A = — 1,321 — 1,500

Shear at C = — 2,821 + 3,021

Shear at L_2 = + 200 — 200

Shear at B = 000

Bending moment at L_1 = — 280 × 13. = — 3,640; 9,179 × 4.5 = 41,305; 37,665

Bending moment at A = — 1,321 × 20.5 = — 27,080; 10,585

Bending moment at C = — 2,821 × 4.5 = — 12,695; — 2,110

Bending moment at L_2 = 200 × 10.5 = 2,100

Bending moment at B = — 10

It will be seen by comparing Figs. 2 and 3 that the bending moments are greater for the conditions shown in Fig. 2 than for those shown in Fig. 3, so the size of the beam at L_1 and A can be made such that the stress will not exceed 5,000 pounds, with a bending moment of 40,300 inch-pounds at L_1, and 41,910 inch-pounds at A. Since the moment of inertia of a circular section is $\frac{\pi D^4}{64}$, the diameter necessary to resist the bending moment of 40,300 inch-pounds

$$= D = \sqrt[3]{\frac{40{,}300 \times 64}{2\pi\, 5{,}000}} = \sqrt[3]{82.1} = 4.35 \text{ inches, use 4.5 inches.}$$

Since the upper end of the air-pump rod is 2 inches in diameter and pierces the beam, the section of the beam in way of the rod will have a moment of inertia of

$$\frac{\pi D^4}{64} - \frac{2D^3}{12} = \frac{D^2(3\pi D - 32)}{192}$$

In order to resist the bending moment of 41,910 inch-pounds with a stress of 5,000 pounds, the diameter will have to be such as to satisfy the following equation:

$$D^2(3\pi D - 32) = \frac{41{,}910 \times 192}{2 \times 5{,}000} = 805$$

By trial we find that $D = 5.87$ satisfies the equation. We will use 6 inches diameter and flatten it off a little at top and bottom to provide bearing for the nut and shoulder of the rod.

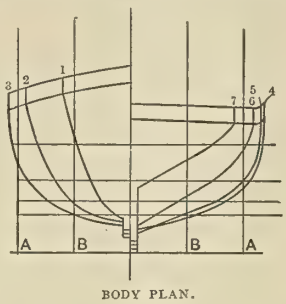
The bending moment on the beam half way between F and L_1 will be one-half of what it is at L_1, so the diameter there must be at least

$$D = \sqrt[3]{\frac{20{,}150 \times 64}{2\pi\, 5{,}000}} = \sqrt[3]{41.5} = 3.46, \text{ use 3.5 inches.}$$

The beam between A and C could be turned down to 4.5 inches diameter if desired, but usually it is left as shown in Fig. 1.

long and the aft deck 6 feet long. The cockpit is sealed up on the inside with ⅜-inch cypress, and has a seating capacity for about twenty-five people, the seats being of ⅞-inch cypress with oak nosing, on both sides of the cockpit, with lockers underneath.

The forward locker is so arranged that the gasoline (petrol) tank may be taken out, and the flooring throughout the launch

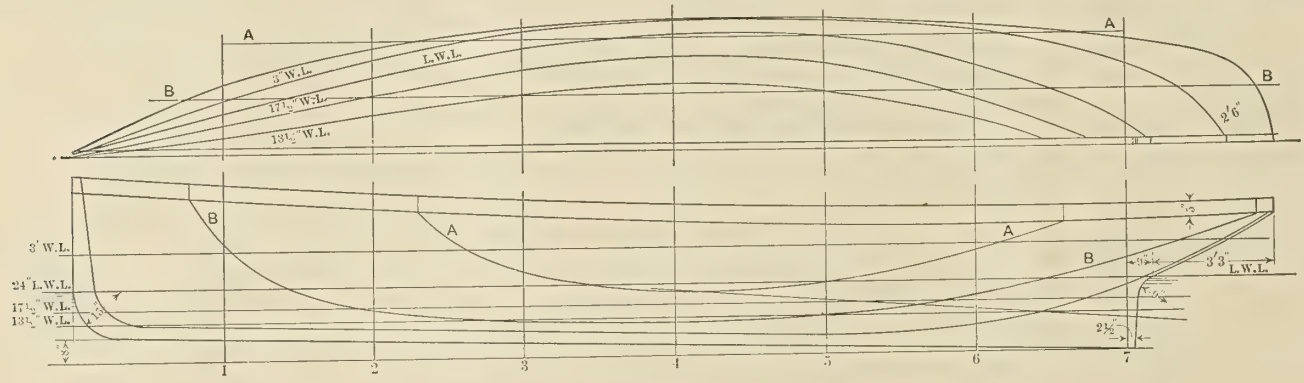


BODY PLAN.

is put down so as to facilitate cleaning of bilges. The ordinary steering wheel and drum are supplied, actuating a bronze rudder, 14 inches by 24 inches. The gasoline (petrol) tank is of galvanized iron, and holds 35 gallons. It is fitted with two interior bulkheads, to prevent swashing of the oil in a seaway.

The floors are ⅞-inch by 3-inch oak, and the engine foundation is of 2-inch white oak.

The power is supplied by a four-cylinder, four-cycle,



LINES OF LAUNCH FOR ISTHMIAN CANAL COMMISSION.

GASOLINE (PETROL) LAUNCH FOR THE ISTHMIAN CANAL COMMISSION.

BY STEPHEN P. M. TASKER.

The illustration shows a type of boat recently designed and built for the Isthmian Canal Commission for use in Colon harbor. The boat is an open launch of sound and heavy construction, designed to be seaworthy and capable of standing a considerable amount of rough sea. It is 32 feet long, with a beam of 7 feet, a draft of 2 feet, a freeboard at the bow of 3 feet and at the stern of 2 feet 1 inch, and a minimum freeboard of 1 foot 11 inches.

The keel is of oak, 4 inches thick, sided 5 inches, and the ribs are of sound, white oak, 1¼ inches square. The shear strake is of 1-inch white oak, with half-round oak strips at the top and bottom running the full length of the boat. The planking is ⅞ inch white cedar, copper fastened throughout, and the hull is sheathed with 14-ounce copper to a height of 3 inches above the waterline. The deck beams are of oak, 1¼ inches by 3 inches, and the coaming is of white oak, extending 8 inches above the deck level. The decking is of quartered white oak, laid fore and aft, blind fastened. The decks are laid flat and fitted with two bow chocks, two quarter chocks and two deck cleats with bronze. The forward deck is 7 feet

medium-duty gasoline (petrol) motor of 10 horsepower with reverse gear, make-and-break ignition and Bosch magneto timed with the motor. The propeller shaft is of Tobin bronze, 1¼ inches diameter. The propeller itself is a solid three-blade manganese bronze wheel, 18 inches diameter and 18 inches pitch. The pitch is kept down in this case on account of the work required of the motor and launch. The bore of the motor is 3½ inches and the stroke 5 inches. With the reverse gear it weighs 560 pounds. The normal speed is 600 revolutions per minute and the minimum 125. The diameter of the crankshaft is 1½ inches and the exhaust pipe 1¼ inches, with ½-inch sea connections. The circulating water is carried around the exhaust manifold, and then overboard, but there is a by-pass, so that the cooling water can be discharged into the exhaust pipe and pass out with the spent gases at the stern, thereby keeping the temperature of the pipe down considerably. It is a good plan to use this by-pass, and just before the motor is stopped to shut the valve and discharge all water overboard. By running a short time with no water passing through the exhaust pipe the pipe is heated and thoroughly dried before the motor is stopped. This lengthens the life of the pipe considerably. The exhaust pipe with the muffler is carried aft and discharges above the waterline under the counter.

This launch was designed by Tasker & Strawbridge, engineers and naval architects, Philadelphia, Pa.

THE MARINE STEAM ENGINE INDICATOR — IX.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

REDUCING MOTIONS (CONTINUED).

Every marine engineer who has served on vessels with vertical propelling engine is more or less familiar with the lever reducing motion in one or more of its various forms. In nine cases out of ten he has probably used gears like that shown in Fig. 61 or Fig. 63. These gears contain the minimum number of parts, are easy to lay out and make, and give a reciprocating motion, and that is about the best that can be said of them. In length, the main levers are about one and one-half times the engine stroke, and the deviation of the actual gear from a true motion is not quite as great as shown in the figures. These diagrams have been purposely drawn with short connections in order to make the errors visible at a glance.

Referring to Fig. 61: *A B* is the line of stroke of the engine. The pin attached to the cross-head is indicated at 5.

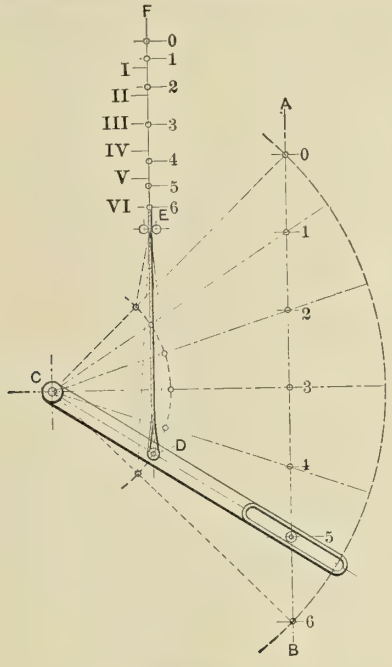


FIG. 61.

The position of this pin when the engine is on the top and bottom centers is at 0 and 6, respectively. Five equally spaced intermediate positions are indicated at 1, 2, 3, 4 and 5, the stroke being thus divided into six equal parts. The lever fulcrum is attached to the housing at *C*. The bight of the indicator cord is slipped over the pin at *D*, rove through a fair-leader or guide pulley at *E*, and thence to the indicator drum. The fair-leader at *E* has purposely been placed close to the lever in order that the effect of the cord angularity may be readily observed. The horizontal lines at the right of *F E* and numbered from 0 to 6 show the actual spaces passed over by any point on the indicator cord, while the horizontal lines to the left (marked in Roman numerals) indicate what the true position should have been when the engine cross-head was at the correspondingly numbered positions on its line of stroke. A glance at the diagram will show that the arcs described by the main lever are not equal for equal movements of the cross-head.

In Fig. 61 the distance from 3 to *C* is equal to one-half the engine stroke, and therefore the arcs described by the lever in its movement from 0 to 6 are as follows for each equal space passed over by the cross-head: 11° 19′, 15° 15′, 18° 26′, 18° 26′, 15° 15′ and 11° 19′.*

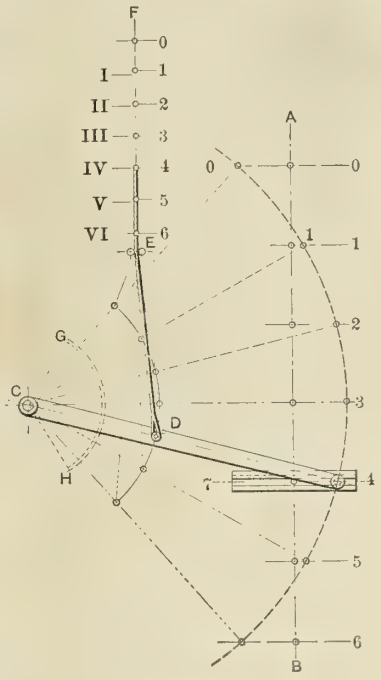


FIG. 62.

Fig. 62 shows another form of simple lever. Here a horizontal slotted guide is fitted to the cross-head, which guide engages a fixed pin in the lever end. This pin passes over equal divisions of the stroke with the cross-head, and if it were not for the necessary angularity of the cord, this gear would be

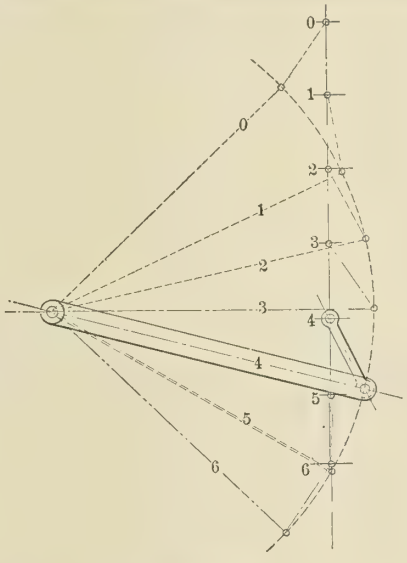


FIG. 63.

accurate, and where the cord is long, the deviation from a true motion is very small. In the movement illustrated in Fig. 61, the lever described the smallest arcs when near the ends of the stroke. In Fig. 62 the reverse is the case, and the arcs are as follows: 18° 35′, 15° 31′, 14° 29′, 14° 29′, 15° 31′, 18° 35′; the distance from the pin center at 4 to the fulcrum at *C* being equal to four-sixths of the engine stroke. This gear gives the same motion as that obtained from the mechanism shown in Figs. 53 and 54 (March issue).

* Copyright, 1910, by Charles S. Root.

* Tan 0C3 = 3/3 and 0C3 = 45°.
Tan 1C3 = 2/3 and 1C3 = 33° 41′ +.
Tan 2C3 = 1/3 and 2C3 = 18° 26′.

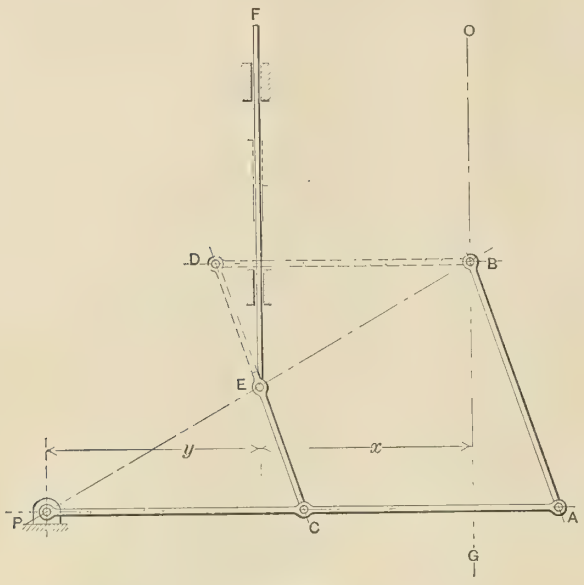


FIG. 64.

A device known as a brumbo pulley is sometimes fitted to levers of this kind. It consists of a sector with a grooved edge, around which the cord is passed. The arrangement is indicated by the broken lines at *C G H* (Fig. 62), the cord being fastened at *H*. While this pulley disposes of the cord angularity, it preserves the entire angular error and is better omitted.

A reducing motion, which is perhaps more common, is illustrated roughly in Fig. 63. It is easier to make and fit than those connected by sliding contacts, but the reduction is still more irregular, as may be seen by a glance at the cut.

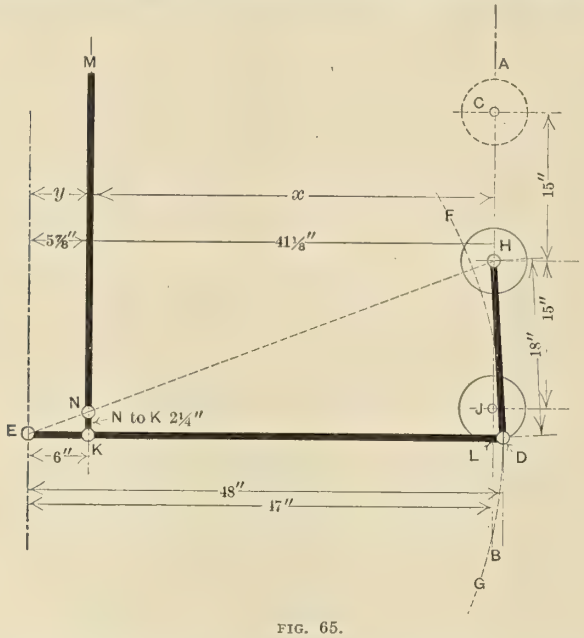


FIG. 65.

As marine engines are almost always provided with a reducing motion, constructed at considerable expense and designed for the particular engine to which it is attached, there can be no excuse for fitting a gear which is sure to give inaccurate readings, when one which is absolutely correct in design can be made at small additional cost.

The principle of the pantograph was discussed at length in the August, 1909, issue, but for the convenience of the reader who has not that paper at hand the subject will be briefly reviewed here. Consider the diagram, Fig. 64. *C D* is a continuous bar, with an intermediate eye at a point to be determined. *A B* equals *C D* in length. *A P* is another bar of any desired length, with an eye at *C* located at a distance from *A* equal to *B D*. The bars are connected by pins at *A, B, C* and *D*, forming a parallelogram. *P* is a fixed bearing on the engine housing, and *B* is attached to the engine cross-head. Draw the line *B P* and drill *E* at the point where it cuts the center line of *C D*. Now, in whatever position this mechanism is placed, *B, E* and *P* will lie in the same straight line,* and any motion imparted to *B*, whether curved, irregular or straight, will be copied by *E*, but on a smaller scale.

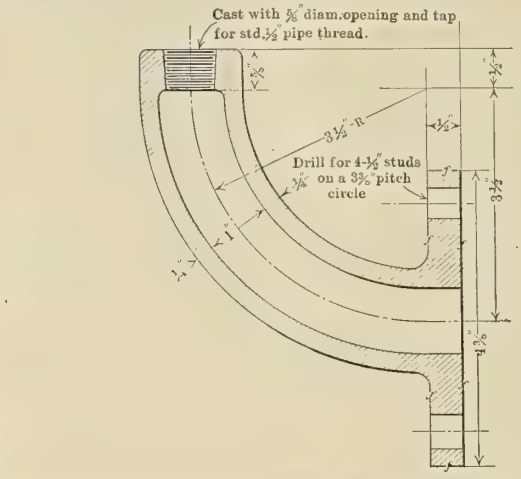


FIG. 66.—LONG-TURN FLANGED ELBOW FOR L. P. ENGINE. MAKE TWO OF COMPOSITION.

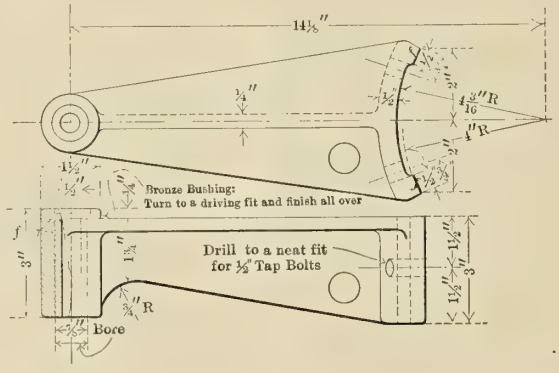


FIG. 67.—UPPER GUIDE FOR L. P. ENGINE. MAKE ONE OF CAST IRON.

The ratio of reduction will be *E P* ÷ *B P*, or, what is the same thing, *C P* ÷ *A P*. Now, as *B* is attached to the engine cross-head, it must necessarily move in the straight line o *G*, parallel to the engine center line and at a distance *X* from o *G*, will move in a straight path parallel with the same line. If a rod be connected to *D C* at *E*, arranged to work in guides parallel to the engine center line and at a distance *X* from o 6, it follows that that part of the mechanism shown in broken lines (*B D E*) may be removed without destroying the pantographic principle in the constant velocity ratio $\frac{y}{y+x}$.

* By geometry: "If a line be drawn between two sides of a triangle (in this case *A P* and *B P*) parallel to the third side (*A B*), the triangle formed (*C P E*) is similar to the given triangle (*A P B*)." Also, "if triangles are similar, their homologous sides are proportional." As *A B* and *C E* are parallel by construction, these theorems apply here, and $\frac{CE}{AB} = \frac{CP}{AP}$. Multiplying both sides of the equation by *A B*, we have $CE = \frac{AB \times CP}{AP}$, from which we see that *E* must always occupy the same place on *C D*, because the second or right-hand member of the last equation is composed of constant factors. The same reasoning applies to all other forms of the pantograph.

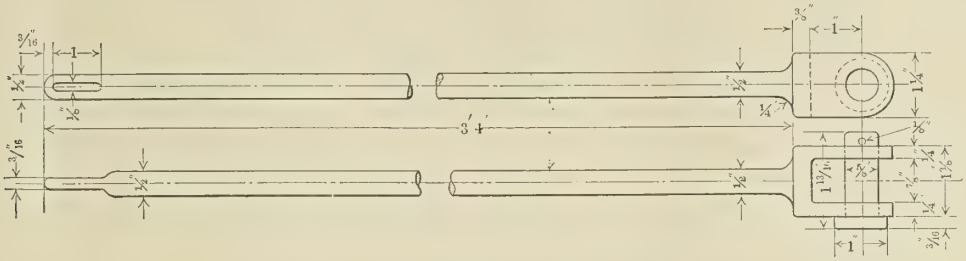


FIG. 68.—GUIDE ROD FOR L. P. ENGINE. MAKE ONE OF MILD STEEL.

To lay out a practical gear of this kind we should proceed somewhat as follows: Consider, first, the card length, or the vertical travel of the guide rod *E F* in Fig. 64. With low rotative speeds a large diagram is possible and desirable, and

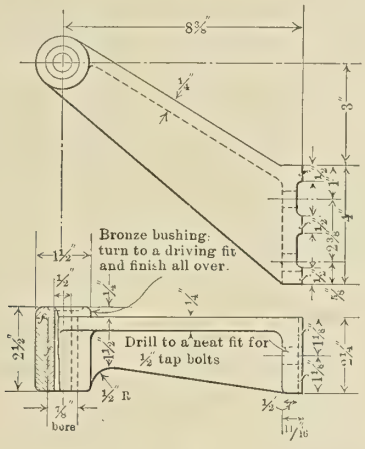


FIG. 69.—LOWER GUIDE FOR L. P. ENGINE. MAKE ONE OF CAST IRON.

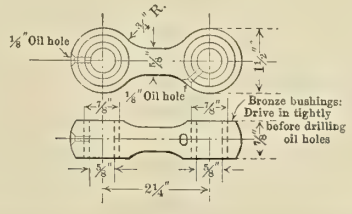


FIG. 70.—GUIDE ROD LINK. MAKE ONE OF MILD STEEL.

some indicators admit of a drum travel, which gives a card 5 inches long; but as the revolutions increase, the diagram or card length must be diminished, in order that distortions, due to inertia, may be reduced to the lowest terms. With speeds below 100, cards of 4 inches length and over are proper; between 200 and 100, diagrams between 3½ and 4 inches should be provided for. For still higher speeds the maximum lengths recommended are: for 300 revolutions per minute, 3¼ inches; for 400, 3 inches to 2¾ inches, and for 500, about 2½ inches.

Problem: Given a high-speed short-stroke engine, with cast back columns bolted to the condenser top; revolutions per minute 160; stroke 30 inches; center line of the cylinders to back of the housing at the condenser top 49 inches; center line of the cross-head pin on the top center to the top of the lower

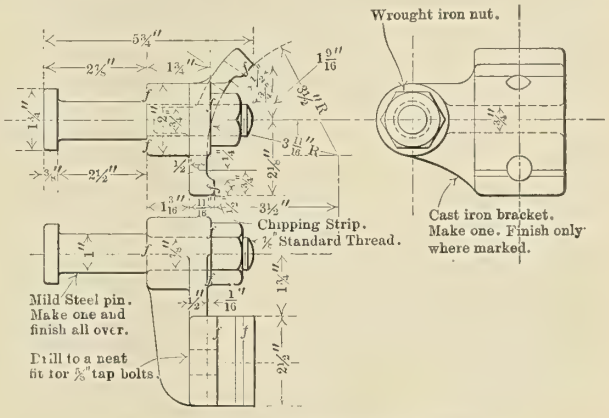

Wrought iron nut.
Chipping Strip. ⅛" Standard Thread.
Cast iron bracket. Make one. Finish only where marked.
Mild Steel pin. Make one and finish all over.
Drill to a neat fit for ⅝" tap bolts.

FIG. 71.—LEVER BRACKET FOR L. P. ENGINE.

housing flange 34 inches; length of the indicator diagram 3½ to 4 inches.

Required: A dimensioned sketch of a correct reducing motion.

Lay down the center line of the engine *A B* (Fig. 65). Locate the center of the cross-head pin when on the top center at *C*. Inspection of the engine frame shows that the center of the main-lever fulcrum can be conveniently located one inch above the top of the lower housing flange and 3 feet 11 inches from the center line of the cylinders. Measure down 2 feet 9 inches from *C* and draw *D E* at right angles to *A B*. Locate the main lever fulcrum center on this line 3 feet 11 inches

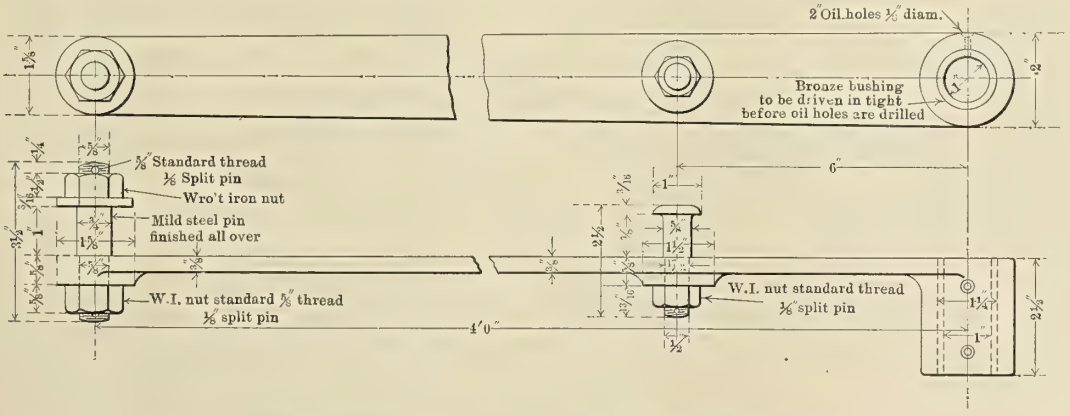

2" Oil holes ⅜" diam.
Bronze bushing to be driven in tight before oil holes are drilled
⅝" Standard thread
⅛ Split pin
Wro't iron nut
Mild steel pin finished all over
W.I. nut standard ⅝" thread ⅛" split pin
W.I. nut standard thread ⅛" split pin
6"
4'0"

FIG. 72.—LEVER FOR L. P. ENGINE. MAKE ONE OF WROUGHT IRON.

to the left at *E*. As it is desirable, but not necessary, that the main lever end swing a little on each side of *A B*, try 4 feet for the lever length, and with this radius and *E* as a center, sweep in the arc *F G*. From *C* measure down 15 and 30 inches and locate the cross-head at mid stroke, and at the bottom center at *H* and *J*. From *H* to the intersection of *A B* and *D E* is found to be 18 inches.

Use this length for the cross-head link and draw *H D*. Divide the stroke of the engine by the card length for the velocity ratio. In this case, for a 4-inch card, it is found to be 7½. As this ratio will give inconvenient fractions, try 8, and we get a card $\frac{30}{8}$ or 3¾ inches long, which is within the limits set. This means that the pin on the main lever for the

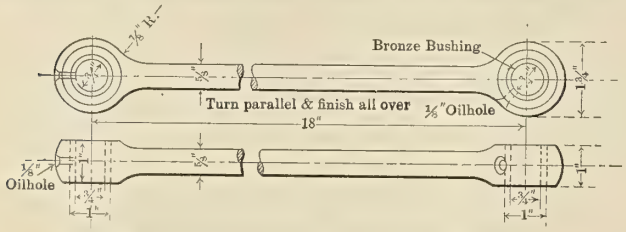


FIG. 73.—CROSS-HEAD LINK. MAKE ONE OF MILD STEEL.

short or guide-rod link must be located one-eighth of the lever length from its fulcrum. From *E*, measure $\frac{48}{8}$ or 6 inches to the right and mark the short link pin center at *K*.

To locate the guide rod: Let the athwartship distance between the engine center line and the guide rod center line be denoted by *x*. The value of *x* is found by the proportion *x* : *D K* :: *L E* : *D E*. Substituting the dimensions already found, we have

$$x : (48 - 6) :: 47 : 48$$

That is, $x = \frac{42 \times 47}{48}$ or 41⅛ inches.

Set off this distance to the left of *A B* and draw *M N* parallel to it. Draw *N K*, the guide-rod link. Let *y* represent the length of *N K*; then *y* : 18 :: 6 : 48 and *N K* will be

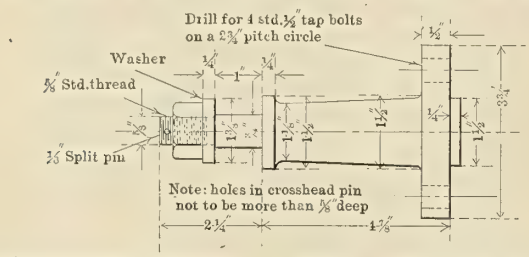

Drill for 4 std.⅛" tap bolts on a 2¾" pitch circle
Washer
⅝" Std. thread
⅛" Split pin
Note: holes in crosshead pin not to be more than ⅝" deep
2¾"
1⅞"

FIG. 74.—CROSS-HEAD STUD FOR L. P. ENGINE. MAKE ONE OF MILD STEEL.

$\frac{18 \times 6}{48}$ or 2¼ inches long.

A reducing motion of this kind in arrangement and details, as actually fitted—with such modifications as experience has shown to be desirable—is shown in Figs. 66 to 75. The drawings are self-explanatory.

This mechanism has been in use for over ten years and has given the utmost satisfaction. It will be noticed that all wearing parts are fitted with removable bronze bushings, and that the cross-head stud is so made that the original lathe centers are preserved. This last detail is of no little importance when it comes to truing up these important journals after years of wear.

(To be continued.)

Reinforced Concrete Barges.

The construction of three reinforced concrete barges for use on the Pacific Division of the Panama Canal has been started at Corozal. Each will be 64 feet long by 24 feet wide and will have a depth of 5 feet 8 inches. The interior beams and columns will have a spacing of 10 feet longitudinally and 8 feet transversely. Two interior longitudinal walls will extend through, with a bulkhead at each end forming an interior compartment, 40 feet long by 8 feet wide. The shell of the barges will consist of one layer of ½-inch mesh No. 12 wire cloth, ½-inch transverse rods, spaced 8 inches on centers and ½-inch longitudinal rods, spaced 12 inches on centers, all securely fastened to the reinforced concrete frame work. Over this several coats of Portland cement mortar will be laid, with an additional coat laid on from the inside.

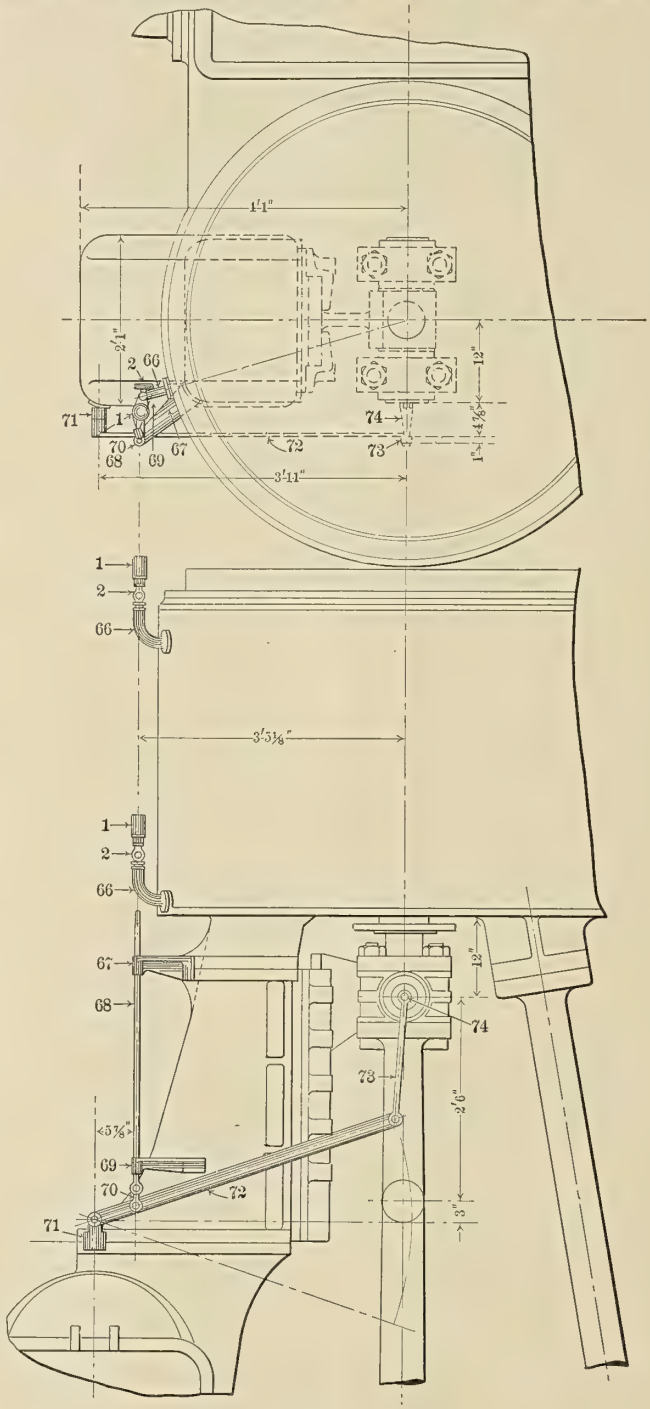


FIG. 75.

DANISH PETROLEUM AND CRUDE OIL MOTORS.

BY AXEL HOLM.

Petroleum and crude-oil motors are in extensive use all along the shores of Denmark as main and auxiliary power for fishing vessels, a trade which puts a very severe test on a marine motor. It would probably be hard at present to find a fisherman on the Danish or Norwegian shores not fully familiar with the handling and treatment of a petroleum motor, and as a result manufacturers of this special type of motor have attained very nearly the ideal combination of reliability, economy and simplicity.

It was the severe competition with trawlers and other steam-fitted vessels from more wealthy countries, such as England, Germany and France, that first forced the fishermen and the manufacturers on this road, and it is remarkable that it is now due solely to the extensive use of motors in the trade that the Danish fishermen are able to keep pace with the foreigners and make a living on their native waters. It is also a matter of fact, that when the British government in 1905 appointed a board for investigating the same problem for Scotland, viz., how the Scotch sailing-fishermen could be helped in the competition against the steam-fishermen, the board found the most available motor for the purpose in Denmark.

Up to the present date these motors have been installed principally in old sailing vessels, never intended for internal motive power, and often put down in the crew's cabin, where they have worked satisfactorily for years, but, of course, now the fishing boats are especially designed and built for carrying motors as auxiliary power. The advantages of these motors, even when compared with the producer-gas motors, are apparent when it is considered that they are constructed to work with heavy, cheap oil, without electrical or open-flame ignition, and without a carburetor or other sensible vaporizer.

Motors on these principles are especially built by three firms in Denmark, the Dan Marine Motor Company, Copenhagen, L.; the Mollerup Motor Works in Esbjerg, and the Alpha Motor Company, Brothers Haumoller, in Frederikshaven; but as they are all very much alike, only differing in the arrangements and details, I can explain them altogether from a drawing of a Dan motor (Fig. 1).

The fuel (petroleum, kerosene or any kind of heavy oil) is carried in tanks as usual, but the tanks need not be arranged higher than the motor, or with internal pressure in order to force the fuel to the carburetor, as it is pumped out by a pump on the motor, and neither need the outlet be put in the bottom of the tank, thus preventing leakages. But even with a leaky tank this kind of oil, when collecting in the bilge, causes no danger of explosions in the engine room, as would be the case with gasoline (petrol). It is said that the woodwork of the boat will, time after time, be saturated with petroleum, but this matter has not caused any serious accident so far, and it might be prevented, to a certain degree, by proper care. On smaller-sized motors the tank is usually placed directly on the motor on brackets from the bedplate (*F T*, Fig. 1).

The oil is forced by the fuel pump into a heated chamber *V* on top of the cylinder and in free connection with it by a narrower neck, but with no connection at all with the air and exhaust valves which control the admission and expulsion of the main charges. The oil is instantly converted into vapor by being sprayed on the red-hot walls of the vaporizing chamber without causing any deposit to form upon the walls. The fuel is taken through a fine sieve before entering the pumps. The vapor is not mixed with air immediately upon its admission, but remains unexplosive until the compression stroke. The valves for the exhaust and air admission *E* and *A* are arranged side by side, both being spring valves and governed by a secondary half-speed shaft, which also operates the fuel and water pumps.

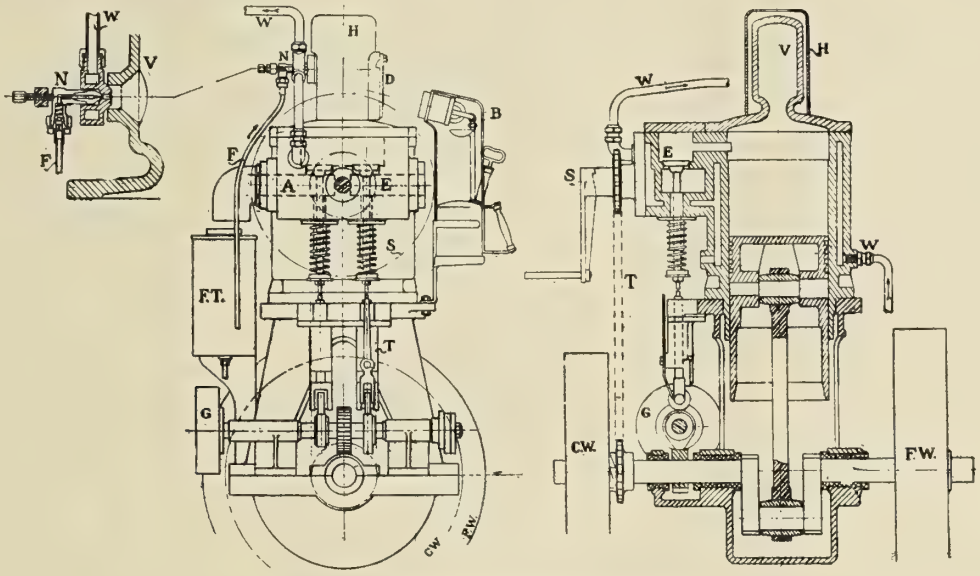


FIG. 1.—DETAILS OF SINGLE-CYLINDER DAN MOTOR.

As these motors are all of the four-cycle type, during the first downward stroke the piston draws in air through the valves, together with a small quantity of vapor from the chamber, into which the fuel is sprayed at the end of this stroke. In the second stroke upward the air is compressed, its temperature thereby raised and forced with great velocity through the narrow neck into the hot vaporizing chamber, where it mixes with the petroleum vapor and becomes inflammable. The ignition will take place in the chamber before the end of this stroke (at from 80 to 120 degrees F.), but on account of the narrow neck and the force of unmixed air rushing through it, the explosion cannot spread to the cylinder before the piston starts the third and power stroke. The fourth stroke is the exhaust stroke. It is claimed that the motors practically never miss an explosion, and that the expulsions are perfectly clean and smokeless. The compression is not very high, about 45 pounds per square inch, the explosion pressure ranges between 130 and 150 pounds per square inch, and the mean pressure is only about 30 pounds. This accounts for the comparatively large dimensions of the

motors. The speed ranges between 300 and 400 revolutions per minute.

From the foregoing it is evident that the motors work on the old original four-cycle system and no new or experimental principles are developed.

The governing of the fuel supply is done both automatically and by hand. The fuel pump draws at each stroke a small quantity of oil from the tank and delivers it directly through the sprayer-nozzle *N* into the vapor chamber, but the amount injected is varied in accordance with the load on the engine by the governing mechanism *G*, which automatically alters the stroke of the pump plunger if the speed of the motor tends to increase. A hand adjustment, secured by a thumbscrew in reach of the helmsman, acts directly upon the governor, and the quantity of oil admitted to the engine thus allows any speed to be maintained for as long a period as may be desired. With the additional control, permitted by the use of a reversible propeller, the management of the vessel is very simple and effective, being under perfect control of one person and calling for no special skill or training.

The water-cooling system is very elaborate, the cylinder, the valves, the sprayer-nozzle, the muffler and sometimes the protecting hood over the vapor chamber all being cooled.

When the engine is to be started, the flame from a wickless self-vaporizing blow lamp *B* is directed against a certain portion of the walls of the vaporizer through a door *D* in the protecting hood *H* for about ten to fifteen minutes. When at the end of this time the bulb becomes glowing hot, the crankshaft is rotated and the motor thus started by means of a self-raising handle and a separate shaft and a transmission chain *S* and *T*. In this way a man can start the motor standing right back of it, and no space is required forward of the fly-wheel for the starting handle and the fore-and-aft length of the motor is thereby reduced as the forward engine room bulkhead can be placed close to the fly-wheel. By this operation the piston is caused to move through the charging and compression strokes and to inhale and mix the vapor and air previous to the ignition stroke. After two or three revolutions the motor commences to work, and after a few minutes the blow-lamp can be taken away, as the vaporizer is thereafter kept at a constant high temperature by being subjected to the heat of the regular explosions inside. The stopping is done by cutting off the oil supply.

The glowing vaporizing bulb is, of course, the most delicate point on these motors, as it seems liable to crack from the heavy stresses put on it from inside, when the material is furthermore weakened by the high temperature, but good material and workmanship will provide against this, and the protecting hood over the bulb will keep the pieces of a broken bulb from doing any damage by flying around in the motor room. In fact this trouble very seldom occurs and has never caused any serious accident during the time (over ten years) that these motors have been in use. The bulb cannot be water-cooled, of course; but it is always covered by the hood, and this on some of the engines is water-cooled.

The mufflers are usually placed directly on the motor, and the exhaust is practically noiseless. There is considerable noise in the engine room from the valves, but this is of only minor importance in the kind of work for which these motors are constructed.

The motors are always started free, and the propeller coupled on after the start—all kinds of couplings being used, but usually friction couplings—and the reversing is now always done by reversing propellers. After many experiments this has been decided as the most reliable device for heavy work.

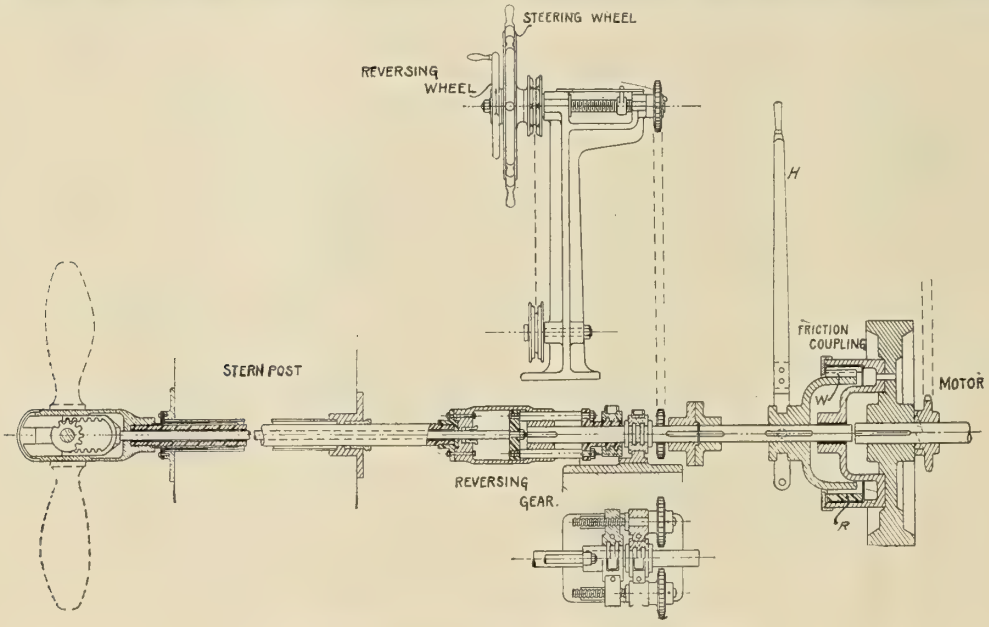


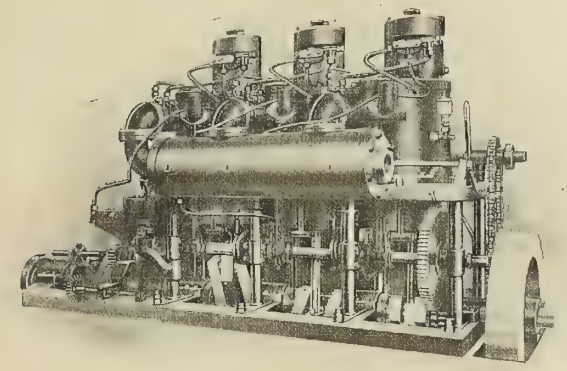
FIG. 2.—COUPLING AND REVERSING GEAR OF DAN MOTOR.

In the plan, Fig. 2, is shown the friction coupling and reversing gear of a Dan engine. In the friction coupling is a steel spring-ring *R* cut at a point, and by moving a wedge *W* in this cut in a forward direction the ring is widened out and brought into strong friction over its whole surface with the friction wheel on the motor. The control of the wedge is by means of a handle *H* as shown. The reversing is done by the helmsman by means of a swing working by a transmission chain on two screws on both sides and parallel to the propeller shaft, and these screws will move the reversing rod in the hollow propeller shaft in a fore-and-aft direction. An indicator on the swing-stand always shows the helmsman the position of the propellers. Apparently this arrangement will require a long shaft, thus making the engine room of considerable length in the fore-and-aft direction, but one must remember that this reversing gear can be put way aft where the lines of the vessel are fine and the space practically useless, or under the cabin floor where it is well out of the way.

Due to the fact that the combustion of the fuel is complete, these motors can be run months without any cleaning of the cylinders and valves. When troubles of this kind at last occur, they generally originate from the clogging up of the fine opening in the sprayer-nozzle of the fuel-supply pipe, but as this is held in its place on the vaporizing chamber, to-

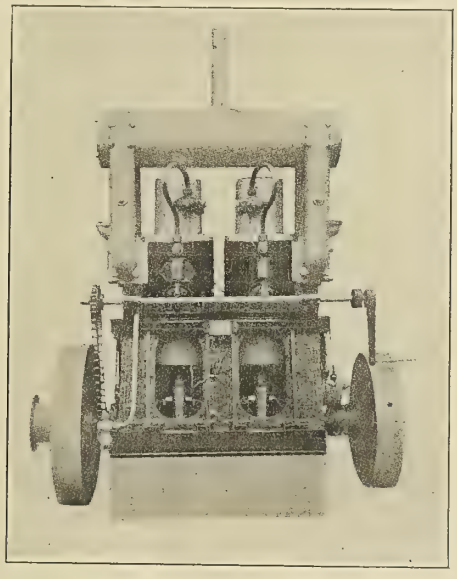
gether with its water-cooling collar by only one screw, it may be quickly removed and the opening cleaned by a piece of fine wire. The mouth-piece is also interchangeable, and a spare piece can always be kept in reserve. This whole arrangement is shown in detail in Fig. 1

As they are intended for rough and heavy work, the motors are quite heavy, the weight being about 275 to 500 pounds per brake horsepower for single-cylinder engines, 200 to 350 pounds for two-cylinder, and 150 to 300 pounds for three-cylinder engines, not including propeller, propeller shaft, reversing gear and tanks. The consumption is stated by the manufacturers to be as low as ½ pound per horsepower per hour for common Texas oil, and is guaranteed not to exceed 1 pound per horsepower hour. In his report to the British



THREE-CYLINDER, 30-HORSEPOWER ALPHA MOTOR.

government, Lieutenant Cummings states that the 25-horsepower Dan motor experimented with would use for one-half penny's worth of oil per horsepower hour, and for a run of 17 hours' duration 40 gallons of oil. The boat used was an ordinary Scotch fishing smack, measuring 72 feet over all, with 21 feet beam and drawing about 8 feet of water aft. The fuel may be the ordinary commercial petroleum with a



40-HORSEPOWER MOLLERUP MOTOR.

specific gravity of 0.8, or crude oil of about the same specific gravity, but the motors can be run on any kind of cheap and heavy oil when specially arranged for it.

As previously stated, the fishing trade is putting the severest test on a marine motor as to its reliability and handiness, and it certainly is surprising to see these motors, rusty, dirty and roughly handled, working steadily away without trouble for

TYPICAL DANISH FISHING SMACK FITTED WITH A 10-HORSEPOWER MOLLERUP MOTOR.

years, managed by the fishermen themselves with very little cost. The Danish government uses these motors at the Greenland shores, and between the Danish Antilles. They are in use in East India and in South America, they are winning their way all along the European shores, and, while the United States, so far has not been tried as a market, it is probably due to the high import duty on machinery.

MODERN MOTOR BOATS.

BY GEORGE H. CUTBUSH.

The development of the internal-combustion engine has opened up many new fields, but none more extensive than that offered by vessels of moderate size. The introduction of a motor giving a high power for its weight made possible many types of boat hitherto impracticable, while in the case of low powers it has already largely replaced steam, and in the case of higher powers promises to do so at no distant date.

In the present article, however, it is not proposed to discuss the future possibilities of the internal-combustion engine, or whether it will ever successfully compete with the powerful triple and quadruple expansion engines and the turbines employed on liners and warships, but to review present practice, and to show how such engines are daily altering existing conditions and giving more efficient service than has been practicable hitherto.

There is not much history attached to the motor boat, less even than attaches to the motor car, as the former to some extent started after the latter had surmounted its early difficulties. As far back as 1863 an internal-combustion-engined boat was in commission. This boat, the *Djezisely,* was the property of the Marquis d'Naie d'Aulais, and was fitted with a Lenoir engine, driven by gas stored in cylinders under pressure. Failing the gas producer, which even yet is not altogether practical, it was by the use of the oil engine alone that the motor boat was developed, and it was not until car makers had shown how light and compact the internal-combustion engine could be constructed that motor boats became popular.

At first they were pleasure craft only, and the same type of engine as used in cars was mostly employed. It was soon recognized, however, that land and marine conditions are very different. In the first case, the engine but seldom exacts its full power, running mostly at a half or a third of its capacity. The marine engine, however, has to run practically constantly at full load, and therefore its speed, if undue wear is to be prevented, must be considerably lower than that of the car engine. Reducing the speed necessarily entails an increase of weight, and so we find marine engines of considerably greater

weight for their power than car engines. In the smallest engines used for pleasure craft the weight is not much greater, but engines for industrial boats are generally heavily built. In Europe the motor boat has suffered somewhat from its connection with racing. Light racing engines on car lines, fitted into the lightest of hulls, gave speedy but unreliable craft, and it is only since it came to be recognized that the marine engine was an entirely distinct type that real progress has been made. In the States, on the other hand, racing has played but a small part in the development of the marine motor, and accordingly American engines quickly became popular on account of their reliability, with the result that large numbers of such motors, chiefly of the low-powered order and many of the two-cycle type, are yearly imported into the United Kingdom and the Colonies.

The principal factor in marine engine design is its constant running under full load. For this reason all bearings and seatings must be of ample area, and cast iron will be found a better material for the crank case than aluminum. Noise and vibration are noticeable in a boat, and as they depend largely upon speed the revolutions must be low. For marine steam engines a piston speed of about 600 feet is rarely exceeded, and this figure may be taken as a suitable one for marine internal-combustion engines of any size.

Lubrication is another important detail, and for good results under all conditions some forced feed system is well nigh essential. While over-lubrication is to be avoided on the score of waste, it is not so objectionable as in the case of a car engine, as the exhaust is in all large boats turned into a funnel.

Small marine sets up to 20 horsepower should be as far as possible self-contained with control board, magneto or accumulators, reverse gear, etc., all mounted on the one frame, so as to require a minimum of trouble when installing in the hull. Many boat builders capable of turning out an excellent hull are not to be relied upon in fitting the engine, and the power plant should therefore be as complete in itself as possible to avoid mal-alinement. As already mentioned, cast iron is the best material for the crank case, as it is far stiffer than aluminum and gives a rigid seating for the bearings, while it is not attacked by sea water as aluminum is. The bearings should be carried on the lower half of the case, and the arms for securing the engine to the bearers also. Doors should be provided in the crank chamber of sufficient size for the main bearings to be inspected or adjusted without taking down the engine. With engines of any size accessibility is a highly important feature, owing to the limitations of space in the usual engine room. Engines should be designed so that all repairs and renewals can be made without taking the engine out of the boat, as in many cases the presence of the deck would render this a matter of difficulty. It should be possible to adjust or replace any bearing, or even remove the crank shaft, with the engine in place. In this connection engines should be accessible from the side, as to remove a cam or crankshaft endwise would entail an engine room twice as long as the engine. To again revert to the crank case, it is by no means certain whether the larger types of marine engine running at comparatively low speeds need to be enclosed. An open engine is light, and lends itself to examination while running. In the case of a hot bearing, water can be run over it, while repairs or adjustments are facilitated. In this connection it is interesting to note that the *Gregory,* the only high-speed motor boat to cross the Atlantic, is fitted with open engines carried on steel columns. The installation of this craft consists of two six-cylinder petrol engines of 12 inches bore and 14 inches stroke, giving a total horsepower of about 700, driving twin screws. The engines are reversible, this operation as well as starting being carried out by compressed air. For engines of this power, however, gasoline (petrol) is out of the question, on account of its expense, and heavier oils are advisable.

Motors are now on the market capable of utilizing the heaviest of crude oils. The Diesel, for instance, will run on the same oil that is employed for liquid fuel purposes, and while somewhat heavy for its power, it is one of the most economical power producers extant. With most of the engines using heavy oils, some little time is required for heating the vaporizer when starting, and this, while not of much consequence in an industrial craft, is out of the question in a small pleasure boat. For commercial work gasoline (petrol) is, of course, not to be thought of, so in many cases kerosene (paraffin) gives the best compromise in conjunction with a reliable and weather-proof system of electric ignition.

For purposes of comparison, the weights of the different types of engine may be of value. With high-speed steam engines designed for continuous service, it has been found impossible to obtain more than 3-horsepower per hundredweight, and this exclusive of the weight of the boilers and their contents. The heavy oil engine gives practically the same power for weight, although some of the largest engines give considerably less (Diesel 1-horsepower per hundredweight), but it must be remembered that the weight of the boilers, feed pumps, etc., is saved. Kerosene (paraffin) engines as fitted to pinnaces, yachts, etc., run from 2½ to 3-horsepower per hundredweight for the complete installation. High-speed engines for racing boats are in use, giving 5.3 to 6.4-horsepower per hundredweight of complete equipment on continuous runs of a few hours' duration. For hard and efficient service, however, about 3-horsepower per hundredweight for engines under 100-horsepower, this including reversing gear, etc., may be taken as the limit.

Of equal importance to weight, in many cases, is space occupied, and here the internal combustion engine scores every time, making it more suitable than steam in very many instances. Another valuable feature is simplicity. Marine engines are often in the hands of novices, and as a failure may be fraught with serious consequences, simplicity and reliability are very desirable qualities. In many branches of industrial work, such as fishing craft, the men have some knowledge of steam, as they are accustomed to its use for the capstan, but the intricacies of the internal-combustion engine take time to master, with the result that such engines have failed in many instances to give satisfaction. For this reason some consider that a compact steam plant provides a better solution of the problem than the oil engine, and one firm, Scott Engines, Ltd., of Paisley, have designed and fitted to several East Coast fishing boats a steam plant, consisting of a four-cylinder, single-acting engine and compact flash boiler. The engine has the cylinders inclined, so that the entire casing is extremely shallow and can be fitted in the crew space projecting but some 6 inches above the floor. The steam generator, too, possesses the advantage that it can supply the capstan with power, a feat of which the internal-combustion engine has hitherto not been capable.

We will now leave the engine and see how it can be applied to various types of craft, pleasure and commercial. To deal with pleasure boats first, these may be used for river work, for estuaries or for open sea, while motor yachts may be considered as a class in themselves. River boats are generally of the shallow type, and range from the punt, with a 2-horsepower, two-stroke motor, and reversing propeller, to boats 30 feet in length with a four-cylinder engine, with reversing propeller. Messrs. James Taylor, of Chertsey-on-Thames, make a specialty of shallow-draft launches for river and canal use. Their patented design incorporates a flat bottom, which gives stability and carrying power; and the usual tendency of such hulls to rise by the bow and squat by the stern is overcome by arching the floor; from the stern the

highest point being slightly forward of amidships. Aft there is another upwardly curved portion extending from the run to the stern post right over the propeller, so that practically a submerged counter is formed. The cross-section of this portion is rounded to form a tunnel in which the propeller revolves, while a cover allows an inspection of the propeller to be made when desired.

Boats suitable for estuary work are, of course, of deeper and fuller section than those used only up-river, as they have to face broken water. For the open water and general cruising, quite a different type of boat is necessary. Perhaps this type of boat is to be found in no greater numbers than on the Clyde, where the open waters of the Firth, the many arms of the sea and the interesting islands on the west coast have encouraged cruising and developed an extremely hardy type of cabin cruiser. A typical boat of this class is the *Fidus II,* a cabin cruiser 28 feet in length by 7-foot beam by 3 feet 8 inches, fitted with a 12-horsepower Scout engine. This boat is by Maclaren Bros., of Dumbarton, and has been successful in winning the first long-distance race on the Clyde held recently from Hunters Quay to Ailsa Craig and back, a distance of 88 sea miles, and a course held to be proof of a boat's seaworthiness.

For really hard weather many consider that the open cockpit of the usual cruiser is unsuitable, and that built-up topsides on the lines of the American dory are the best. A boat recently completed on these lines is the *Lady Mary,* which is purely American in design, with a big displacement overhanging fore-end and broad quarters. She is 35 feet in length, with a beam and draft of 7 feet 9 inches and 2 feet 6 inches, respectively. Her engine is a 15-horsepower Gardner kerosene (paraffin) motor, driving through a Gie's reverse gear. She has ample cabin accommodation and an enclosed engine room. The auxiliary rig is that of a two-masted schooner and a novel feature is the main mast, through which the exhaust is taken.

The hydroplane depends, of course, upon the presence of a film of air between the hull and the water at high speeds, the low frictional resistance making high speeds possible. The hull is flat, and consists of three or more steps to imprison the air. Broken water, of course, impairs the efficiency of the hydroplane, and for this reason it is not likely to become more than a toy, although the possibilities of torpedo hydroplanes have been discussed, and even of liners built on this principle. For use on smooth water a small torpedo boat on these lines might have some practical value, but it is somewhat doubtful.

Yachts of ever-increasing size are now being fitted with internal-combustion engines. The *Bronzewing* is one of the largest and most luxurious motor yachts in existence. She was built in Sydney, and is used for cruising on the inland waters of the Australian continent, and for journeys to the South Sea Islands, which require a thoroughly seaworthy boat. The length is 120 feet, with a beam of 17 feet, and her hull is of teak throughout. The machinery consists of three sets of 100-horsepower Thornycroft motors, driving triple screws through reversing clutches. The fuel used is kerosene (paraffin), and the engines, which have four cylinders apiece of 8 inches bore and stroke, develop their power at 750 revolutions per minute. A small 6-horsepower engine and compressor provides the compressed air for starting. The use of triple screws makes for economy, as the center engine, or the two wing engines, can be used separately, according to the speed required. A complete installation of electric light and fans is fitted, a separate motor being employed for the dynamo, while the bilge pumps and winch are electrically driven. The exhaust is water-cooled throughout the whole length, and is discharged at the stern above the waterline.

Yachtsmen have not taken very kindly to the motor boat, but many of them recognize that the auxiliary engine is by no means to be despised. Accordingly, every year sees more sailing craft used for cruising fitted with small motors capable of giving a few knots in a calm. There is, as a rule, not much difficulty in finding space for the engine, but the fitting of the propeller shaft in the usual way generally entails considerable alteration of the dead wood at the stern. To obviate cutting of the stern post, etc., the Berguis Launch & Engine Company, of Glasgow, employ a system in which the propeller shaft is taken through the side of the boat as near the center as possible, a course which only entails a bush fitted into the timbers and a bracket at the stern post. The propeller is, of course, of the feathering type, to avoid resistance when the engine is not in use. The engines installed in fishing boats are also in the nature of auxiliaries, the sails being employed whenever the wind is in a favorable quarter. A typical drifter employed in the herring fishing off the east coast of Scotland is the *Sardius.* The over-all length of the *Sardius* is 80 feet and her beam is 20 feet. The engine is a 50-horsepower Thornycroft of the slow-speed type, which will run on gasoline (petrol) or kerosene (paraffin), and starting can be effected either on the former fuel or by means of a blow-lamp. With kerosene (paraffin) at 12 to 14 cents (6 to 7d.) per gallon, this boat can be run for a cost of 48 cents (2/–) per hour. For this type of work there are now many makes to choose from, and, in addition to the Thornycroft and Gardner, probably the best known, there are the Berguis, the Dan, Kromhent, Bolinders, Pasley, Passons and Mear. Other applications of the internal-combustion engine to marine purposes are legion, but those briefly described have been selected with a view to showing the many and various types of boat at present giving efficient service under all conditions in different parts of the world.

A Subsurface Torpedo Boat.

According to the *Army and Navy Journal* a new type of war vessel, provided for by Congress in the Naval Appropriation Act of last year, is to be officially tested by the United States Government at Boston. It is known as the subsurface torpedo boat, and is designed to be immune from the small gun fire now relied upon as a protection against ordinary torpedo boats. It consists of a submarine hull, which contains all the machinery and torpedo armament, suspended from an unsinkable surface hull, divided into compartments packed with cellulose. The boat has had a preliminary trial. Tams, Lemoine and Crane, the consulting architects, report that it easily made 18 knots, thus exceeding the required speed by two knots. Six tons is the weight of the vessel, and its length is 46 feet. The price which the Government has agreed to pay is $22,500. The small subsurface boats can be used either for coast defense or they can be carried on board of the larger vessels in an armored fleet. In the submarine hull is an eight-cylinder gasoline engine, of 150 horsepower. The explosive charge carried is 1,000 pounds of guncotton. A heavily armored conning tower on the surface hull, communicating with the submarine hull, enables the navigator to direct and control the boat's movements. Only two men are required on board. The inventor of the new war vessel is Clarence L. Burger, who received the degree of civil engineer from Princeton in 1885.

A Dumbarton (Ireland) firm has recently completed a new producer-gas-driven motor boat. This boat, the first of its type built on the Clyde, is a 40-foot mahogany cruiser of 30 horsepower with a speed of 10 knots. The motor is of the usual four-cylinder gasoline type, and has been specially adapted for producer gas.—*Motor Boating.*

FUEL OIL.—I.

BY E. N. PERCY.

EXTENT OF WORLD'S SUPPLY AND ITS EFFECT ON COST AS COMPARED WITH COAL.

In 1904 the world's supply, or more accurately, production of petroleum, was over 219,000,000 barrels, of which the United States produced 53.4 percent, or 117,000,000 barrels, at an average price at the well of $0.864 (3/7) per barrel. Of the United States production, California produced 25.33 percent, Texas 19 percent; but the average value was only 26 cents (1/1) per barrel, while Ohio producing 16 percent, averaged more than $1.50 (6/3) per barrel. Of the 46.58 percent produced outside of the United States, Russia averaged 35.82 percent, all other countries from 1 to 4 percent each, as follows:

	Barrels.	Percent.
Canada	492,492	.22
South America	66,200	.03
Gallicia	5,947,383	2.72
East Indies	8,008,000	3.65
Roumania	3,572,625	1.63
India	1,411,975	1.54
Germany	637,332	.30
All other countries	....	.03

By plotting these localities on a globe, remembering that the great Russian production center surrounds the Caspian Sea and vicinity of Baku, it is easy to see that the sources of oil for fuel are more accessible to the Pacific Ocean than the Atlantic; but oil can be freighted cheaper than any other fuel, since no manual labor is required in its handling in bulk from tank steamers. It is pumped to the sea coast in pipe lines wherever possible, and a pipe line crosses the Isthmus of Panama; hence, if the demand existed it could be transported as cheaply as coal to any fueling station in the world. So far as distance is concerned, it might be mentioned that California oil companies are at the present time shipping in bulk, via tank steamers, to Honolulu, Japan and China as high as 40,000 barrels a month, and lime kilns all through the Pacific Coast, at points remote from oil regions, are using upwards of 7,000 barrels per day for fuel. This fuel oil is mostly refuse from the refinery from which the more valuable products have been removed. In refining, many of these oils only give up about 7 percent of their weight in more valuable products, while other oils it does not pay to attempt to refine; while many of the Eastern oils will distill to 10 percent or less of residue, the remainder being various valuable products, hence it is easy to see that if the oil of a certain district can be refined to more valuable products, the price of fuel oil will be governed accordingly, no matter how plentiful the supply. For this reason fuel oil is more plentiful and cheaper on the Western coast of the States than the Eastern.

In 1906 there was produced in the United States 126,000,000 barrels of oil weighing, roughly, 17,000,000 tons, and 414,000,000 tons of coal. As four barrels of oil are roughly equal to a ton of coal, we could say that, in calorific value, 7 percent as much oil as coal was produced; but as the largest consumption of coal is for industrial purposes for which oil could not be substituted, or would not because of remoteness from oil districts, it is safe to assume that there is a sufficient supply for it to be delivered at a reasonable price at any seaport in the world where a steady, reliable demand exists.

United States and Russia, obviously, control the petroleum industry. In view of our immense exports of fuel oil, it is safe to assume that the United States has enough fuel oil so located that it could deliver it at a reasonable price at any port in the country. As will be shown later it is possible for a ship to carry enough oil fuel to make a round trip to any part of the world and return to a given American port, and steamships at this time carrying 14,000 tons of cargo have made the trip around the Horn from San Francisco to New York City with one original loading of oil. Other boats make the round trip to Australia and back. Taking the average price of oil at 85 cents (3/6½) per barrel, and four barrels equal to a ton of coal, we have $3.40 (14/2) per ton as the price of equivalent coal; but to this must be added the dispensing of all the firemen of a ship but one or two per watch, the ease and cheapness with which the oil can be handled and stored, and the extra cargo space it leaves for the ship. Furthermore, 65 cents (2/8½) represents the average price of the crude product, with none of the refining, as the price of actual fuel oil more nearly averages 65 cents (2/8½) delivered on the Pacific Coast in barrels or wagons, and less than this in bulk on contract. Coal which will evaporate 5 pounds of water per pound of coal is worth $1.56 (6/5½) per long ton; average coal evaporating 8 pounds of water is worth $2.48 (10/2½), and high grade rated at, say, 11 pounds water, will cost $3.40 (14/2) per ton. From this it is fair to assume that if a line of tank steamers covered the Atlantic and Pacific coasts, fuel oil could be delivered at reasonable price to any American port, and the entire American merchant marine, American navy and many foreign ships could be operated with fuel oil at less cost and with great profit to the producers.

The merchant marine would have to be educated to its use and experts advise each installation; but since America controls this industry and its cheapest transportation is by tank steamer and oil is a fuel peculiarly suited to marine work, a fleet of tank steamers for domestic and foreign service, fitted to carry part oil and part miscellaneous cargo, would go a long way towards rebuilding our merchant marine and pay well both the owners and oil producers, especially if the ship subsidy bill comes into existence.

Looking over several of the most important fields we find the average price of crude petroleum to be as follows:

California (per barrel)	$0.279 (1/2)
Colorado (per barrel)	1.152 (4/9½)
Indiana (per barrel)	1.079 (4/7)
New York (per barrel)	1.6275 (6/9)
Ohio, Eastern and Southern (per barrel)	1.625 (6/9)
Ohio, Lima (per barrel)	1.103 (4/7)
Mecca-Belden, Ohio (per barrel)	3.725 (15/6)
Pennsylvania, average (per barrel)	1.627 (6/9)
Pennsylvania, Franklin (per barrel)	4.00 (16/8)
Texas (per barrel)	.367 (1/6½)
Russia, Baku	15 kopecks per pood, or $0.78 (3/2) per barrel.
Germany, Alsace and Lorraine (per barrel)	$2.00 (8/4)
Italy, Milan (per barrel)	8.00 (1/13/4)
Rome (per barrel)	3.29 (13/9)
Japan	Varying from $1.00 (4/2) to $3.00 (12/6) per barrel.

In only a few instances, as California, is the oil used for fuel as it comes from the well, hence the above is no criterion of the price of fuel oil but is merely given to show the price of oil at or near the well or oil district.

Having located the great oil districts as lying first in Western United States, the Middle Western States, around the Caspian Sea in Russia and the East Indies, and the average prices of the crude oil at the wells, we will now investigate the price of actual fuel oil residuum delivered at the various seaboards of the world, and where it is obtainable, if at all. We will take the coasts of the three great oceans in rotation.

Pacific Coast—Obtainable only in ports between San Francisco and Los Angeles at an average price of 65 cents (2/8½) per barrel. May be obtained from tank stations in Northern ports at a higher price.

About 3,000,000 gallons a year is shipped to Alaska for steamship and industrial use, but the price, in fact the entire shipments are privately controlled. There are strong indications that a large oil deposit will be uncovered in Alaska within the next few years, which will make the Pacific Coast a stronger factor than ever in this industry. Peru is the only producing district in South America, and only equals 40 percent of what is imported from the United States, and hence there

Note.—As this article is written with special reference to marine oil-burning plants, and as many authorities have been consulted and the data rearranged for this purpose, it is only possible to give the credit due various authorities by saying in a general way that the information here is taken from Government reports, consular reports and various statistical sources, investigated and checked by the writer.

is no place on the South American coast, either side, where petroleum fuel oil may be cheaply obtained.

Hawaiian Islands—Large storage is maintained here by private interests, retailing at an average price of $1.35 (5/7½) per barrel.

Canadian Seaports—About $1.50 (6/3) per barrel.

Black Sea and East Mediterranean Ports—About $1.00 (4/2) per barrel.

The price of oil varies widely with various conditions. For instance, on the Pacific Coast, when the demand is high and the production limited, the price will go above a dollar (4/2), then several new wells will be opened, or a new pipe line finished, and the price will go down again, but it is gradually becoming more and more stable. It would not be an unlikely prediction that in a few years American ships will burn crude oil wherever desired at an average cost of $1.50 (6/3) per barrel. The 65 cent (2/8½) rate referred to for the Pacific Coast applies to delivery under contract in large quantities near the wells, or in bulk from pipe lines or steamers. Delivered at the docks in San Francisco the rate runs from 80 cents (3/4) to $1.50 (6/3). Storage stations are maintained, as stated, in Alaska, the Hawaiian Islands, and many Asiatic ports. The Hawaiian American Line steamship *Alaskan* steamed from San Francisco to New York around Cape Horn and back on one charge of oil fuel. It was all carried in the double bottoms and one large tank. Careful tests on the *Alameda,* belonging to the Oceanic Steamship Company, running from San Francisco to Australia and way ports, showed that 1 pound of petroleum did the work of 1¼ pounds of coal and occupied 40 percent less bunker space, hence if a double load of fuel were carried it would only occupy 20 percent more space than coal, and it could be stowed in the double bottoms or other extra room where it is impossible to carry coal, leaving that space for cargo, amply demonstrating that American ships could run to any port from American shores and return on American fuel. Not only would the fuel be cheaper, but most of the firemen, coal passers and trimmers are dispensed with, and the fire-room is painted up and shined just like the engine room and kept that way. The ship makes better time, as the fires are the same at all times, and never have to be cleaned; and the boilers last longer because their work is evenly applied. With a good fireman, and straight line fore and aft fire-room, one water tender and one fireman can tend any number of boilers, even for the largest ships, and the safetys will never whimper no matter how suddenly the engines shut down, for modern systems of oil burning are centrally controlled, as will be detailed later, and with the first stroke of the gong all of the main fires are out, and only a little pilot flame from a small burner in each furnace, to keep the furnace hot while standing by, and keep the auxiliaries going; even this can be shut off with a twist of the hand, but should be lighted every couple of minutes to keep the bricks red for the main burners.

Returning to the object of this particular article, the world's petroleum supply, we should remember that residuum and crude oil are used for other industrial purposes, such as road making, and the price fluctuates accordingly. California is shipping from three quarters of a million barrels per year upwards to Hawaii for fuel purposes alone. One hundred and fifty-six oil-burning steamers run out of San Francisco harbor, which does not include river boats and bay craft, among which is a fleet of the largest and most splendidly equipped ferry-boats in the world. They number about twenty, and all burn oil. Some are propeller-driven and some by paddle-wheels with low-pressure boilers.

These things are mentioned merely to show the varied classes of marine work in which oil is burned, and the safety with which it can be used, as no service is more trying or risks more lives than ferry service, particularly where the boats leave and arrive on the second, and travel 12 to 15 knots in all kinds of weather.

In connection with the world's supply of fuel oil it should be distinctly understood that the greater part, possibly 60 percent of the amount, is oil, either as residuum or as crude oil that is fit for no other purpose. Bearing this in mind, together with the new fields that are being exploited, it is easy to see that fuel oil will always be available, no matter how much refining is done. In the development of new fields, outside of the great centers of United States and Russia, we find next in importance the East Indies, which produce over 3 percent of the total production. It is a very heavy asphaltum oil, and after distilling about 25 percent for refining the remainder is sold for fuel.

Important discoveries, or indications of petroleum, but comparatively little developed, exist in Newfoundland and Labrador, but no great yield exists. There is every indication of a future large petroleum yield in Mexico, there being many seepages and other indications, but none is as yet developed. There are some indications in Cuba, also. The high duty on petroleum products has compelled Cuba, up to the present time, to import crude petroleum and refine it herself; hence fuel oil is available at a reasonable price there in the form of residuum. Venezuela has a great deal of undeveloped petroleum resources, as indicated by petroleum springs, seepages, oily shales, etc., also asphalt and natural gas. Argentine formerly had enough oil to use as fuel on the railroads but the wells seem to have exhausted, and the roads have gone back to coal. Judging from the geology of petroleum, as generally found, it is hardly likely that the wells are actually exhausted, but merely in need of development. Ecuador has strong and widespread indications, but wholly undeveloped. The country of Peru produces and refines over 2,000,000 gallons of very good crude oil per year, but uses all the residuum for the railroads there and in Chili, and imports 120 percent more crude oil in bulk from the United States besides.

Austro-Hungary and Roumania produce and refine, but have many undeveloped indications. It is not out of place to say that there is no country in the world where people will gamble and take the chances in developing an oil indication like America, which accounts largely for the American petroleum industries, as many wholly undeveloped foreign fields have better indications than are found in California to-day, or ever were; furthermore, the oil fields that are developed in foreign fields, notably those in Russia, have been developed principally through the enterprise of American capitalists and firms.

Germany, while a small producer, refines her oil very highly, and through her skillful chemists secures many valuable by-products, but fails to get down to the broad bulk ideas of handling and marketing oil. The writer has personally seen oil springs and asphalt indications, wholly undeveloped, that would cause a third-class California promoter to guarantee dividends and make market contracts for sales before he had a title to the property. If an American smells oil, or sees a splotch of axle grease he stakes out the property and inquires afterwards. Our foreign neighbors are more conservative, and unless a wealthy company takes hold of a prospect there is little chance of its development, as initiative is not so common as in America.

Italy produces about 20,000 barrels per year, but it is very high grade, and is taxed very highly, bringing its total value to $8.00 (£1 13/4) per barrel.

Large undeveloped deposits exist in Turkey, Armenia, Palestine, Africa, Siam and Persia. India is destined to become one of the greatest petroleum producers on the globe, as the indications are tremendous, but at present she produces only about 5,000,000 barrels per year, at an average price of $1.50 (6/3). China has a few wells of ancient origin, far inland, and only remote rumor gives any information, but it seems that several

grades of crude oil are in evidence; but as the indications are so plentiful elsewhere on the globe, it is probable that it exists in large quantities in various parts of China; at this time large storage stations are maintained at Hongkong and other Asiatic ports, as well as Manila and Japan.

It will thus be seen that the petroleum industry is yet young, and that fuel oil is not going to become scarce; indeed, it now awaits the demand, and fueling stations will be placed wherever it exists. Even Alaska, one-sixth the size of the States, has many indications of petroleum and soft coal. The coal fields that are now so prominently before the public in a well-known discussion are the more ancient and more highly developed carbonaceous asphalts that have hardened into soft coal. The exact geology is still a matter of discussion, but certain it is that we find the successive grades from anthracite down to lignite, peat, asphalt, tar and oil always more or less related; not necessarily near together, but always in a rough, approximate progression from the coal country into the oil country. Wherever beds of soft bitumen coal are found there, not far away, will usually be asphalt and oil; not in the same district, but not far away, and in the same general geology. Great examples of this are Pennsylvania, Russia and the Pacific Coast. The coal beds of the latter are only partially developed, but they exist, and are of immense extent, but of very poor quality, running to peat rather than lignite; therefore, in addition to petroleum seepages, etc., we may conclude, in a general way, that Alaska is destined to be an oil-bearing country, and will probably consume most of her own production.

From the standpoint of fuel oil there are two classes of petroleum as it comes from the well; they are the paraffin base and the asphaltum base. The one boils down by distillation to paraffin, the other to thick, heavy asphaltum. By paraffin is meant the material of which candles are made, not the kerosene called paraffin in England. Fuel oil as it comes from the well may be of any grade and as thin as water, or so heavy that it will not flow without special treatment. It may be light straw, brown or black. Regular fuel oil, as usually left by the refineries, flows easily, is black, with a brown tinge barely perceptible, and about 16 degrees gravity; which means, roughly, that at ordinary temperatures it will not drip off of the corner of a card. Exact characteristics and tests of the various oils will be given later, as will, also, the effect of the different properties and the kind of outfit necessary for each kind of oil.

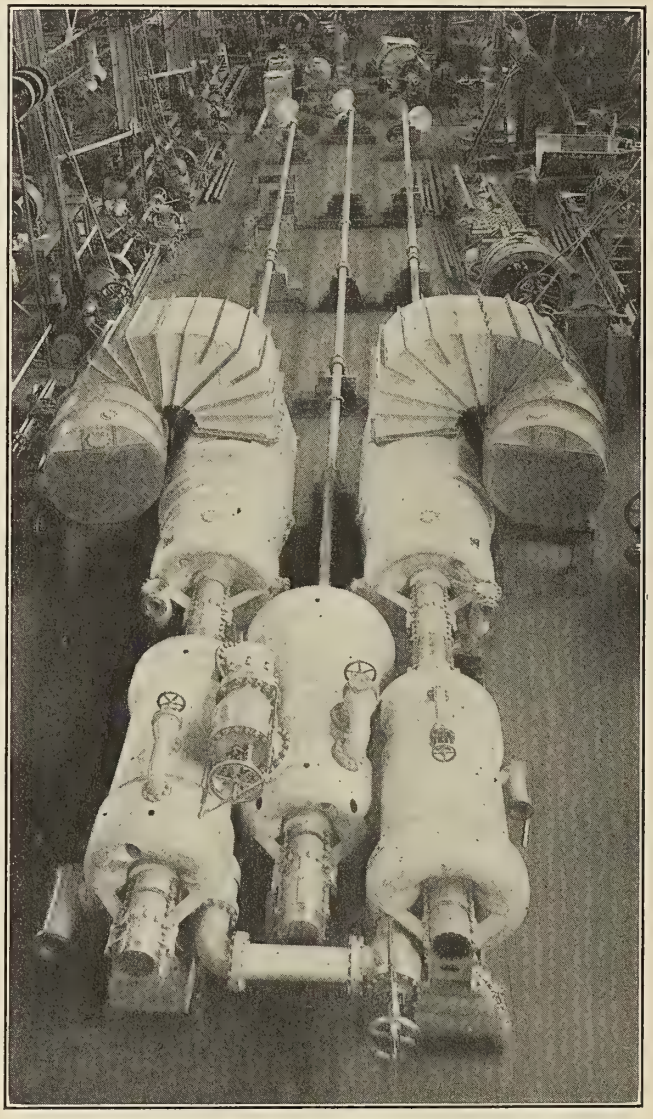
(*To be continued.*)

Turbine Machinery of the U. S. Destroyers Reid and Flusser.

A complete description of the United States destroyers *Flusser* and *Reid,* built by the Bath Iron Works, Ltd., Bath, Maine, was published in our November, 1909, issue, but we have since received a somewhat unusual photograph which shows the turbines, shafting and propellers assembled in the builders' shops. This we reproduce on this page, since it gives an unusually clear idea of the arrangement of turbine machinery for warship propulsion.

There are five turbines of the Parsons type on three shafts, the main high-pressure turbine being on the center shaft; the starboard low-pressure and intermediate-pressure cruising turbines together with the starboard backing turbines being on the starboard shaft; and the port low-pressure and backing turbine and the high-pressure cruising turbine on the port shaft. The steam piping is so arranged that any of these turbines can be run as the initial turbine. Combinations of five, four and three turbines are permissible either by disconnecting the cruising turbines or by permitting them to revolve in vacuum. For cruising at low speeds the high-pressure cruising turbine is made the initial turbine by using its throttle as a modulator. At higher moderate speeds the high-pressure cruising turbine is put out of use, and at the highest speeds the main high-pressure turbine is made the initial turbine.

Steam is furnished by four Normand return-flame boilers, designed for a working pressure of 255 pounds per square inch. These boilers are pitched forward to compensate for the squatting of the stern of the ship at high speeds. Another uncommon feature of the boilers is the length of grate, which is 8 feet 8 3/16 inches.



TURBINE MACHINERY OF THE U. S. DESTROYER REID, ASSEMBLED IN THE BUILDER'S SHOP.

The propellers are three-bladed of solid manganese bronze, the starboard and center screws being right-handed, and the port screw left-handed. The designed pitch and diameter of the propellers are respectively 58 and 63 inches.

Apropos of marine turbines, a contemporary notes that Messrs. Parsons & Company, recognizing the advantages of twin-screw propulsion, as proved in the Curtis equipment of the scout *Salem,* have developed a modified Curtis partial-admission turbine which they are to install in one of the new 5,200-ton, 26-knot British scouts. A sister ship will have Curtis turbines. The Parsons turbines will weigh 340 tons, and guarantee full power on 13 pounds of dry steam per horsepower per hour. The Curtis turbine will weigh 250 tons and guarantee 12.5 pounds of superheated steam.

A NEW FORM OF TURBINE DRIVE FOR SHIP PROPULSION.

With the announcement a few months ago of the successful results obtained by Mr. George Westinghouse with an experimental helical spur gear speed reducing mechanism, designed by Rear Admiral Melville and J. A. Macalpine, to transmit 6,000 horsepower, the practical application of this gear to a turbine-driven ship was considered to be only a matter of time. It is, therefore, of interest to know that Mr. Westinghouse has contracted with the Navy Department to furnish a turbine drive of this type for the new navy collier *No. 8*. While the details of this design of the turbines and reducing gear for the *No. 8* have not yet been approved by the Navy Department, and consequently cannot be made public, yet the general arrangement of this gear is shown in Fig. 1.

The collier is to be driven by twin screws, and the designed horsepower is 7,200. The new Westinghouse marine turbine will be used, giving in this instance an overload capacity of upwards of 8,000 horsepower. The power will be transmitted to the propeller shafts through the Melville-Macalpine speed-reducing mechanism.

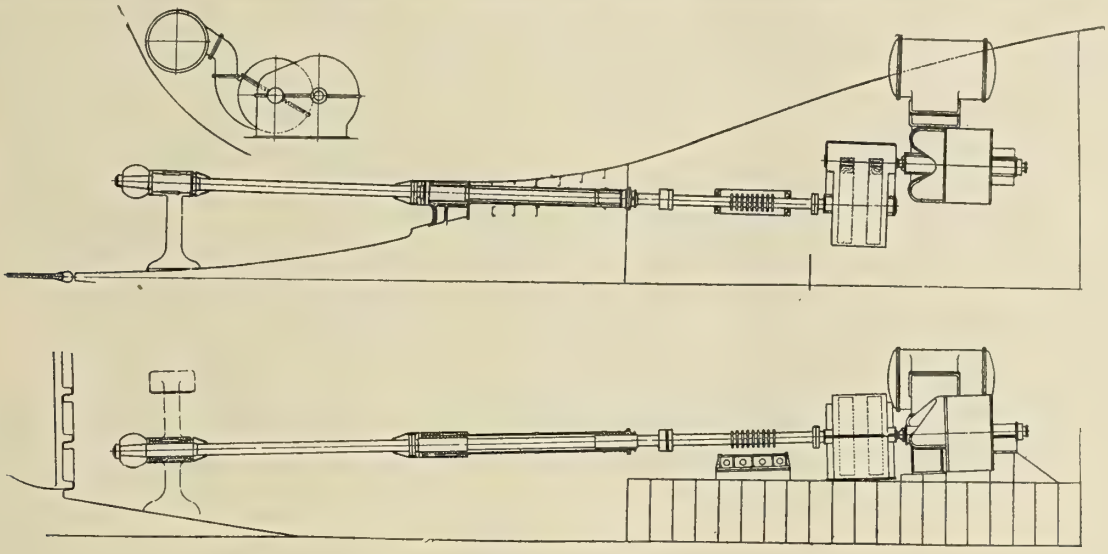


FIG. 1.—ARRANGEMENT OF TURBINE DRIVE FOR U. S. NAVY COLLIER NO. 8.

THE TURBINES.

Each turbine is a complete independent unit with the high-pressure and low-pressure ahead and astern turbines in one casing. A single pipe brings the high-pressure steam to the turbine, and a single exhaust connection to the condenser suffices for the astern as well as the ahead turbine, the exhaust from both sections communicating with each other through the hollow rotor.

The high speed as compared with that of the usual marine turbines reduces the number of rows of blades necessary efficiently to utilize the energy in the steam, and the number is still further reduced by making the first and largest pressure drop through a single impulse wheel instead of through a number of rows of blades of the reaction type. When the steam has expanded to a considerable volume it is handled more efficiently by blading of the latter type; but in the earlier stages of the expansion, where the pressures are high and the volumes comparatively small, the energy is extracted with a properly designed impulse wheel just as efficiently as it could be with many rows of the Parsons type of blades. The greater compactness, due to the use of the impulse wheel, is, no doubt, a valuable feature in a turbine for use on board ship. With this construction, as now well understood, the distance between the bearings becomes short, and the rotor is consequently stiff, and vibration is thus considerably minimized. Moreover, the high-pressure steam at high temperature is confined to the nozzle chamber, so that the range of temperature and pressure to which the casing of the turbine is subjected is much reduced, and consequently there is less tendency for the casing to distort. The ahead and astern turbines have impulse elements of the same size, but in the latter the complement of reaction blading is less. The power available for going astern is, however, unusually liberal, and the economy is sacrificed in a much smaller degree than is usual in marine turbine installations. It should also be remembered that all the propellers are available for going astern, which is a decided advantage.

The impulse wheels have two sets of blade passages arranged concentrically, the outer annulus being considerably narrower than the inner. When the turbine is working at low power one or two nozzles which discharge on the outer or smaller blade ring may be opened. For greater power one or two larger nozzles may be opened to discharge against the inner or larger blade ring. When maximum power is required all of the nozzles and both blade rings are brought into action. The nozzles are so proportioned, and can be operated in so many ways, that the entire range from minimum to maximum power can be covered in convenient steps without throttling the pressure in the nozzle chamber. In other words, the full expansive energy of the steam is available even when the vessel is running at the most moderate cruising speed. Another point worthy of note is that all pipe connections are made to the lower half of the casing, thus enabling the cover to be lifted and swung back on hinges without breaking a single pipe joint. The most notable improvement, however, in the Westinghouse marine turbine is the design of the cylinder blading. It is usually necessary to remove the rotor in order that access may be had to the blades of the lower half of the cylinder.

In order to obviate lifting the rotor when inserting new blades, the American Westinghouse Company has introduced a design of cylinder blading in which the blades are mounted on flexible bronze strips instead of being calked into grooves in the cylinder. The cylinder grooves are made much wider and deeper than usual, and are slightly undercut, leaving overhanging shoulders near the top. These blade strips may be slipped into the grooves, where they cut through into the cylinder flanges, and light springs underneath hold them up against the overhanging shoulders. With this design the whole of the cylinder blading can easily be removed and

replaced without unseating the rotor. Spare blading of this kind can be stowed in a small space, and repairs could readily be made at sea. The bases of these blading strips are extended on one side, so that they project over the tips of the corresponding row of blades in the rotor, forming what is practically a removable bronze lining for the cast iron cylinder. As the blade strips are backed up by flexible springs, the clearances between the tips of the blades and the cylinder, or the rotor, may be reduced to a value that would be impossible with rigidly inserted blades. It has been found practicable to assemble the turbine with the blade tips in actual contact with the base strips and the rotor, and to allow the clearance to adjust itself by actual wear.

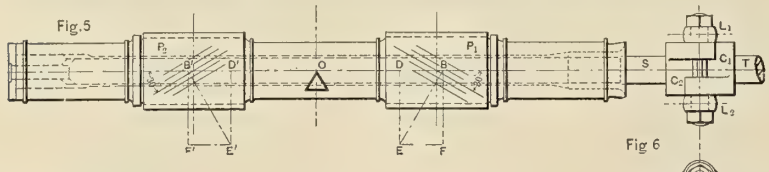
There are two independent valves on each unit, one for the ahead turbine and one for the astern turbine. These valves are operated by levers, and are so designed that a continuous movement of either operating lever from the closed position successively opens all the different combinations of nozzles, admitting the steam in constantly increasing quantities until the maximum power is attained.

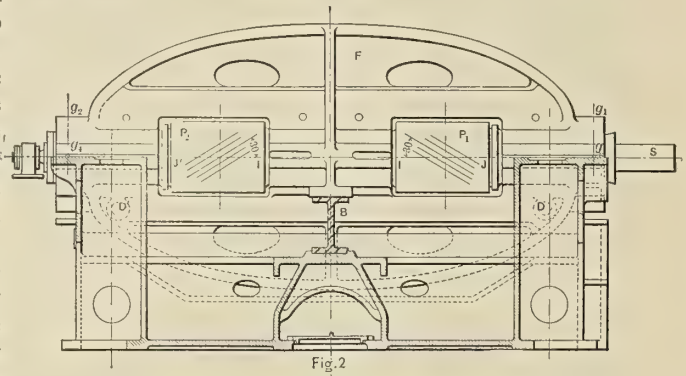
While the turbine may be manually controlled by the engineer in accordance with instructions conveyed by the ordinary ship telegraph, it is possible to control it directly from the bridge, or from any one of several points on the vessel, by means of an electro-pneumatic operating gear working on the throttle valve levers.

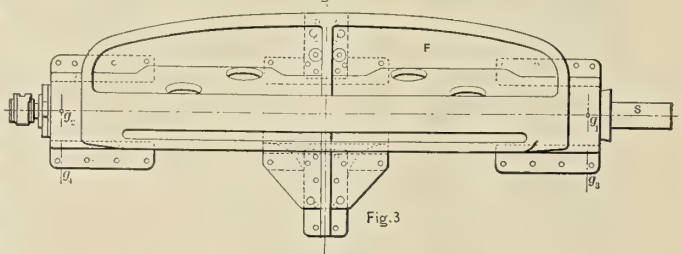
THE SPEED REDUCTION GEAR.

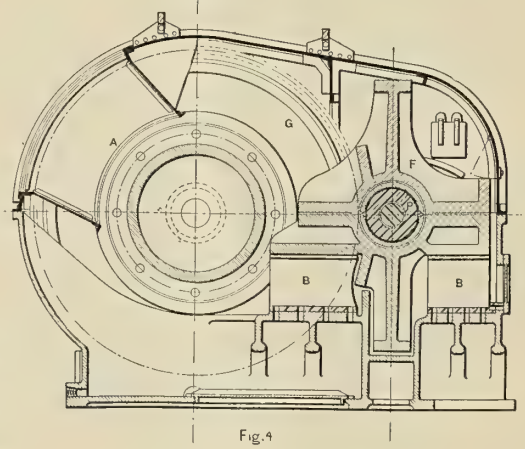
The speed reduction gear can best be described by the following abstract from an article published in *Engineering*, describing the design and construction of an experimental gear designed to transmit 6,000 horsepower at 1,500 revolutions of the pinion per minute, the reduction ratio being about 5 to 1. A perspective view of the gear with the casing partly broken away is shown in Fig. 7. In this case the device is coupled to a Westinghouse double-flow turbine.

The pinions have 35 teeth each and the spur-wheels 176, a hunting-cog being introduced to equalize wear. The pitch is 1¼ inches, and the pitch helices are at an angle of 30 degrees









DETAILS OF REDUCTION GEAR.

with the axis of the shaft. One wheel and pinion have, of course, right-handed helices, and the other pair left-handed, so as to eliminate end-thrust. The diameter of the pitch circle of the large wheels is about 70 inches, and of the pinions 14 inches. Details of the gear-box are shown in Figs. 2, 3 and 4. These have been designed after a long and comprehensive study of the circumstances which tend to interfere with the proper working of very broad teeth. A small pitch was deemed essential if a reasonable absence of noise was to be secured, and this necessarily meant broad teeth, in view of the fact that 6,000 horsepower was to be transmitted with a pitch-line speed of very nearly 100 feet per second, and with a limiting pressure of 453 pounds per lineal inch on the teeth.

In order to ensure the proper working of such broad teeth, Messrs. Melville and Macalpine have adopted the plan of mounting the pinion shaft in a device which they have dubbed a "floating frame," the object of which is to cause the alignment and position of this shaft to be controlled wholly by the interaction of the teeth in contact, and not by the greater or lesser skill of the workman in laying out and fitting the bearings, which, moreover, even if exactly right to start with, could not be depended on to maintain permanently their alignment. The "floating frame," which is lettered *F* in Figs. 2 to 4, is a heavy steel casting flexibly mounted in the gear-box and supporting in rigid bearings the pinion shaft, but in such a way as to allow of this shaft having a slight longitudinal freedom, so that it can slide axially to and fro within the frame.

Fig. 2 is an elevation of the floating frame showing the flexible I-beams *B*, on which it is supported from the bed-plate. The pinion, it will be seen, is supported in three bearings, the center bearing dividing the tooth faces P_1 and P_2, of which P_1 is right-handed and P_2 left-handed. The large gear, being much stiffer, requires only two bearings. The floating frame is made very deep vertically, so as to be exceedingly stiff to withstand deflection by the nearly vertical forces at the bearings. It is also amply stiffened in the horizontal plane to obviate deflection from the weaker horizontal forces. The floating frame is shown in plan in Fig. 3, while Fig. 5 shows the pinion shaft and the flexible shaft *S* by which it is driven. At the end of this shaft is a coupling *C* driven by the turbine-shaft *T*. The axes of the gear and pinion are horizontal and parallel to one another when everything is in correct adjustment. But it will be evident that the I-beams *B* are virtually a hinge, and if the large gear *G* was not in place, or the coupling *C* connected, the axis of the float-

ing frame and pinion could easily be deflected in the vertical plane through a small angle by a slight flexure of the webs.

The coupling consists of two flanges C_1 and C_2, mounted on the shafts T and S, and connected by two transverse links L_1 and L_2, and by a center pintle, care being taken not to make this restraint redundant. The shaft T can, therefore, only rotate the shaft S through the links L_1, L_2, but as these are transverse, no longitudinal forces can be transmitted. Even when seriously out of adjustment, the longitudinal forces are so small as to be negligible. The pinion, therefore, has perfect freedom of longitudinal movement in its bearings. Further, the pinion is driven by the shaft S, which passes completely through it to the end distant from the coupling, where it is keyed and bolted. This shaft is so flexible that it imposes practically no constraint on the pinion and floating frame such as would prevent slight angular yield of the I-beams B. It is evident, therefore, that, both as to its longitudinal position in the floating frame and in the angular position of its axis, the pinion is solely under the control of the forces transmitted by the teeth of the large gear.

Neglecting the very slight friction of the well-lubricated teeth, the total forces at the tooth contacts, indicated by B, E and B^1, E^1, Fig. 5, will be nearly at right angles to the teeth at B and B^1; that is, they will be at 30 degrees to the vertical. Hence the two parallelograms of forces shown will be similar. Now the horizontal forces at $B\ D$, $B^1\ D^1$ are the only axial forces acting on the pinion. If these are not equal, the pinion will at once shift longitudinally, which it is free to do, till they are equal. The two parallelograms of forces then become equal to one another in every respect, and the vertical force $B\ F$ is equal to the vertical force $B^1\ F^1$. But besides this longitudinal movement of the pinion, the frame in which it is mounted is free to rotate about the center point O by flexing the I-beams. Hence it follows that the moment of the vertical force $B\ F$ about O must be equal to that of $B^1\ F^1$ about the same point; and as $B\ F = B^1\ F^1$, the arms of these levers $O\ B$ and $O\ B^1$ must be equal. Thus it is claimed that not only will the total forces on the teeth P_1 and P_2 be equal, but the distribution will be so similar that the centers of pressure B and B^1 will be similarly placed.

This, it is contended, practically assures a good distribution of pressure under all conditions of load. For, by sufficient running of the gear, it may readily be assured for one particular load; and if the pinion and floating frame are made sufficiently stiff, this condition will not be seriously changed by increase or decrease of load. The strength of both pinion and floating frame is far in excess of that requisite to sustain the maximum forces to which they will be subject, and then dimensions were made such as to give ample rigidity. For instance, under full load the flexure of the cast steel floating frame in the vertical plane is so slight that the end bearings will be lowered relatively to the center by not more than 1-2,000 inch.

There is, moreover, a certain compensation for this deflection, owing to the action of the lubricant. When the load on the gear is increased, the end-bearings will be forced down, bending the pinion and making the teeth bear harder at the inner ends I and I^1. Thus more than the proper force will be exerted on the center bearing, and less on the outer bearings. This will at once lead to a thinning of the oil-film on the center bearing, and to its thickening on the outer bearings. As the total thickness of the oil-film is more than twice the yield of the outer bearings, this change in the thickness of the film will go far to compensate for the elasticity of the floating frame.

Given that the axes of the gears are parallel to start with, the action of the teeth will, it is claimed, force the axis of the pinion into exact alignment with that of the large gear, provided that in the flexure of the I-beams supporting the floating frame the pinion shaft tilts in a vertical plane parallel to that containing the axis of the large gear. If there were no floating frame, and all bearings of the pinion and gear were cast in one bed-plate, the longitudinal dimensions remaining unchanged, an error of alignment of the axes in the vertical plane not exceeding 1-1,000 inch in the length over the bearings would entirely upset the uniform distribution of the pressure along the faces of the teeth. Hence, with the most careful work, the above assumptions may not be fulfilled with sufficient accuracy. Even if they were exactly fulfilled when the gear was first completed, inequality of the side wear of the bearings might cause the axes to stand at a sensible angle in the horizontal plane. Provision is made for measuring such errors of alignment.

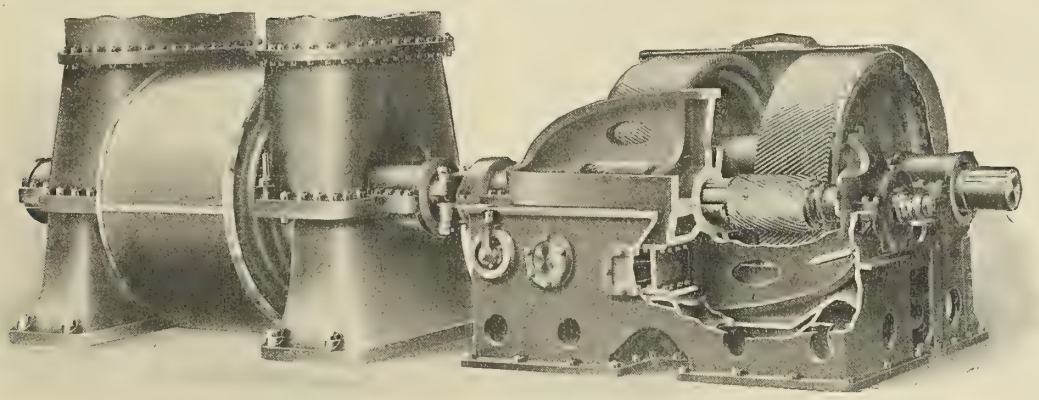


FIG. 7.—MELVILLE AND MACALPINE'S REDUCTION GEAR CONNECTED TO WESTINGHOUSE TURBINE

As to the effects of the elastic strains of the teeth and shafting, steel gears of 1¼-inch pitch are commonly run under a load of 1,000 pounds per inch of tooth face at ordinary pitch-line speeds. As all gears are liable to errors of alignment, this average pressure actually means that at times there will be a maximum pressure very much greater. In the gear under discussion the highest mean value used is less than 500 pounds per inch of tooth contact. Suppose then that by errors of alignment the actual value varied from zero to 1,000 pounds per inch, which is far within the disturbance occurring in ordinary gears. It may be shown that the yield of these teeth under 1,000 pounds per inch is such that the distribution of pressure would close up an opening of contact of nearly 1-1,000 inch. Errors of erection will be exceedingly minute, so that the only errors to be avoided are those due to

unequal horizontal wear of the bearings. Any unequal vertical wear will be compensated for by slight tilt of the floating frame. As the forces on the floating frame are inclined to the vertical at only a small angle, vertical wear will take place much more quickly than horizontal; and as the inequality of the wear will usually be but a small fraction of the total wear, it would be almost impossible for any very sensible angular error in the horizontal alignment, such as assumed above, to creep in before the bearings were worn down a long way vertically, and ready for renewal.

Involute teeth have been used, as they give excellent results. But they have also the well-known property that if, through wear of the bearings or errors in the original setting up, the axes are somewhat farther apart than designed, the teeth still run true, and there is no "opening of contact." This does not hold with any other form of teeth. Hence the solution presented by the floating frame with involute teeth is unique.

From the foregoing it will be seen that the elasticity of the I-beams allows freedom of movement of the axis of the pinion and floating frame in the vertical plane. But by warping the webs of these beams the axis of the floating frame might also turn slightly in the horizontal plane. It is, of course, many times more rigidly mounted against this displacement than against that in the vertical plane, but still the rigidity is by no means complete. It may appear that this is not specially important, as an angular displacement in the horizontal plane, even if of measurable amount, causes no important disturbance. But that is not the only consideration, as the question then arose as to whether with freedom of rotation both in the vertical and horizontal planes the position of the axis of the floating frame would be stable or unstable; that is to say, if forcibly displaced from exact alignment to a small angle in the horizontal plane, will the forces at the tooth contacts tend to bring it back to perfect alignment or to further displace it? By consideration of the slight changes of direction of the forces at the tooth contacts produced by such displacement, it can readily be shown that, with involute teeth, the position of the axis of the floating frame is unstable, and a slight displacement arising from any cause will tend to increase. With the I-beams alone, therefore, there might arise excessive horizontal errors of alignment, and trifling causes might produce sudden and violent changes of the horizontal error, either of which effects would endanger the whole mechanism. The floating frame has therefore been deprived of all freedom of motion in the horizontal plane by means of two horizontal struts standing transversely between the floating frame and bed-plate. Obviously these struts in no way interfere with the freedom of movement of the floating frame in the vertical plane. Where they bear in the bed-plate there is an adjusting and locking mechanism which greatly facilitates the true setting up of the floating frame, and is to be seen in the perspective view in the front of the bed-plate, near the end next the turbine.

The only condition which could cause serious disturbance of the tooth pressures is an excessive heating of the pinion above the temperature of the gear. But the design provides for a copious application of lubricating and cooling oil, especially to the pinion, which has most tendency to heat. The cover, also, is so arranged as to draw in air at the ends at *A*, Fig. 4, by the fan action of the gears, and discharge it by openings (not shown) to the right of this cross-section. Besides, water can be circulated, by means only partly shown in the figures, between the pinion and the flexible shaft *S*.

At 1,500 revolutions per minute of pinion and 453 pounds per inch of tooth contact, the gear will transmit 6,000 horsepower. The pitch-line speed would then be 5,500 feet per minute, and the mean speed of sliding about one-tenth this, or 550 feet per minute.

Similar gears could be applied to any speed of ship. This design would then be of the correct power for the *Dreadnought,* and applied to her, it is claimed, would save fully 50 percent of the weight of her turbines, besides reducing boiler weights, since both turbines and propellers would now be of considerably enhanced efficiency.

Increasing, by the law of comparison for similar machines, the dimensions and power of the present design, from 6,000 horsepower, a size is obtained suitable for the *Mauretania* with three large screws of the same total power as the present four-screw ship. Here, again, the weight of the turbines would, it is claimed, be halved, as also the engine-room length. The boilers also, as in the *Dreadnought,* would, it is considered, be materially reduced.

In Fig. 8 the upper views represent the *Mauretania* thus modified, as compared with the existing arrangement shown in the lowest of the three views. For warships the saving effected by such a gear should, it is claimed, be considerable, especially at cruising speeds. The *Mauretania* is supposed to be capable of developing 70,000 shaft horsepower. Even the comparatively low speed at which these turbines run is too high for maximum propeller efficiency. It is hardly possible, it is estimated, that the propeller efficiency exceeds 55 percent, which means that the actual effective propelling power is only about 38,500 horsepower. At a lower speed of revolution, well within the capabilities of the reduction gear, it is claimed that a propeller could be made that would have an efficiency of not less than 65 percent. With this improved efficiency, the shaft horsepower required for the same effective propelling power would be somewhat less than 57,000, a saving of almost 15 percent. This means that without sacrificing in the smallest degree the remarkable speed of these vessels, the boiler equipment could be reduced about one-seventh, as well as the amount of coal burnt on each voyage. This would obviously not only result in a very marked saving in capital investment and operating expenses, but would add many tons to the cargo-carrying capacity and add considerably to the earning power. But, it is contended, this estimate, large as it is, is still too modest. With the turbines and propellers direct connected so that they both revolve at the same speed, not only is it necessary to sacrifice the efficiency of the propeller but the efficiency of the turbine as well. For equal efficiencies in any two turbines the number of rows of blades is, roughly speaking, inversely proportional to the square of the respective peripheral speeds of the rotating elements. The peripheral speed of the rotating elements in the turbines of the *Mauretania* and *Lusitania* is only about one-third of the speed common in large turbines used on land. This would mean that to obtain the efficiencies common to the latter the former would require approximately nine times as many rows of blades, which would make a machine of prohibitive length. To maintain the same speed of revolution and increase the peripheral speed of the turbines of these vessels to the point common in land practice, the rotors would have to be nearly 40 feet in diameter, which is manifestly beyond the shadow of possibility.

It is believed that the steam consumption of the turbines of the *Mauretania* and *Lusitania* cannot be less than 14.5 pounds per shaft horsepower per hour, while it has been demonstrated that turbines of similar capacity, operating at speeds which the reduction gear makes possible for marine service, the steam consumption does not exceed 11 pounds per shaft horsepower per hour. This means that the boiler capacity could be further reduced from the first estimate of 60,000 horsepower to about 45,000 horsepower; and it is claimed the over-all efficiency of the installation would be sufficiently improved to result in a reduction of over 35 percent in the coal consumption. It has been reported that the coal consumption of these vessels is 4,700 tons per voyage. Taking coal at $3.25 (13/6.5) per ton, the saving in coal alone would be $5,300 (£1,060) per

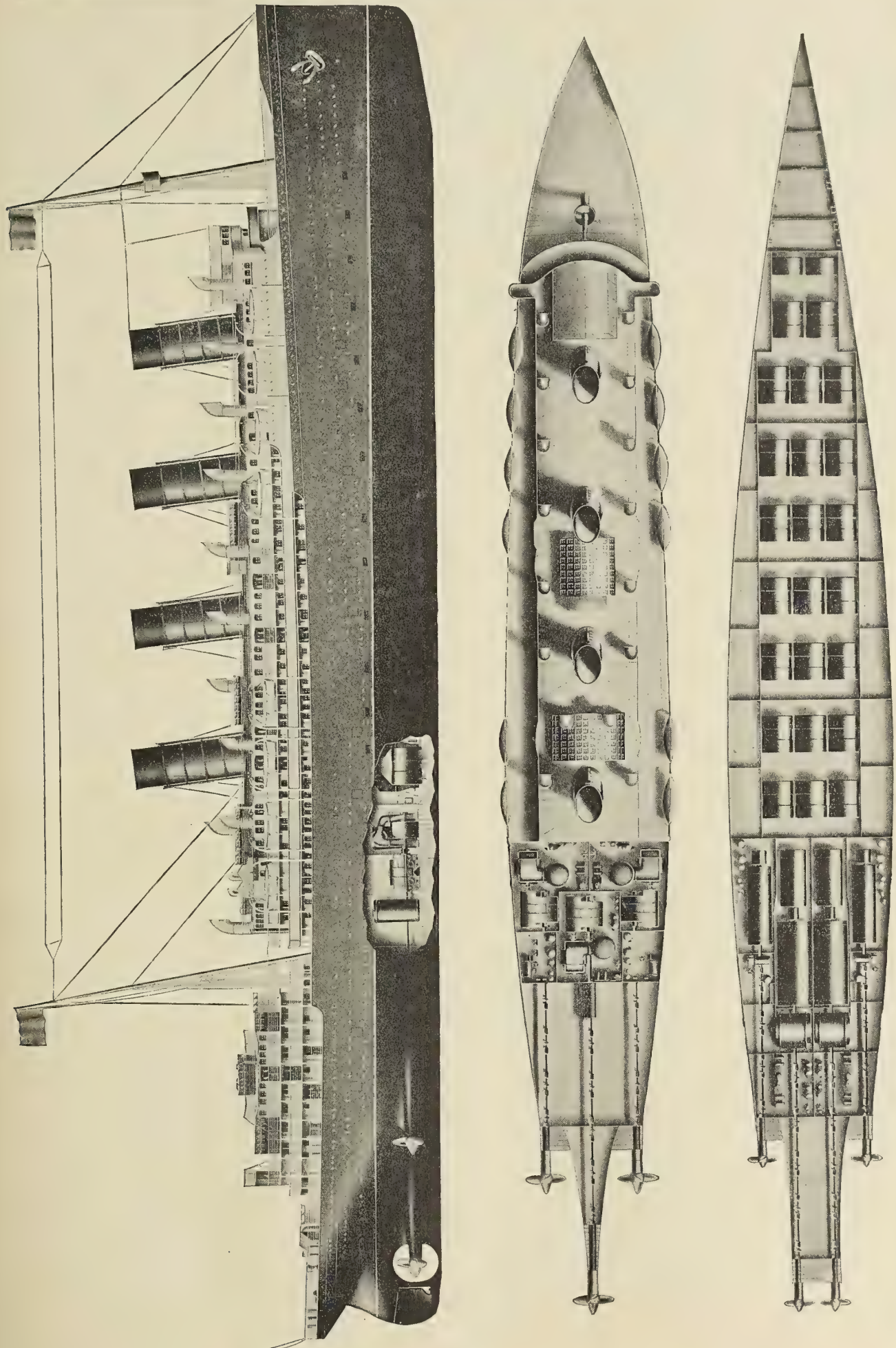


FIG. 8.—DIAGRAM ILLUSTRATIVE OF RELATIVE SPACES OCCUPIED BY GEARED AND DIRECT-DRIVING TURBINES IN S.S. MAURETANIA.

voyage, to say nothing of the smaller cost of wages. The increased cargo capacity resulting not only from a reduction of over 1,600 tons in coal, but also from the greatly reduced weight of the equipment and the space necessary for it, is an asset the value of which is difficult to estimate. A great deal more might be said about the advantages which his gear is claimed to have, but the above is sufficient to show that they are by no means negligible.

RESULTS OF TESTS.

The experimental gear was tested by means of a specially designed hydraulic absorption dynamometer, by means of which the measurement of the power output of the gear was accurately obtained. To measure the power input it was necessary to determine accurately the horsepower of the turbine. This was done by taking advantage of the fact that as long as the speed and exhaust pressure are maintained constant the absolute inlet pressure of commercial dry steam at any instant is a very accurate measure of the brake horsepower the turbine is developing. By substituting for the reduction gear a dynamometer connected directly to the turbine shaft, and operating the turbine at a fixed speed and with a constant vacuum in the exhaust pipe, the inlet pressures corresponding to different loads at this speed were determined, and the turbine thus calibrated. A check on this method of determining the power input to the gear was afforded by the measurement of the heat appearing in the oil used for lubricating the gear. Of course, the loss of power in its transmission by the gear appears as heat in the oil, and this can be determined with a degree of accuracy, the only source of error being the heat radiated from the gear casing and from the oil piping.

By these methods the efficiencies of the gear when transmitting different quantities of power were found to be consistent and uniform, ranging from 98.5 to 99 percent.

Dutch Marine Suction-Gas Plants.

BY F. MULLER VAN BRAKEL.

The financial calculations in the November issue on working cost of marine suction-gas installations, as compared with oil and steam plants, close with tables showing the yearly costs of different-sized ships and engine plants. The yearly costs for the ships have no influence on the comparison, and might have been omitted so far as it concerns this point. They are only given to show the financial influence of the ship relatively to the costs of engine and fuel. To get at the total yearly costs, wages and harbor duties should be added. For the 120-ton boat this would be: Skipper, $400; 1 man and 1 boy, $325; harbor duties, $30; total outlay for ship, $598 + $400 + $325 + $30 = $1,353. For the 300-ton ship the total yearly outlay would be: Skipper, $400; mate, $250; 2 men and 1 boy, $525; harbor duties, $70; depreciation, etc., $1,092; total, $2,337.

To compare gas with steam or oil it suffices to give the total outlays for engine and fuel. It should be observed that the 120-ton gas motor boat has a disadvantage of 3½ tons cargo capacity against the oil-motor boat, while the 300-ton gas boats have an advantage of 17 tons against the steam boats. For the greatest part differences originate in the producer installation weights for the 120-ton boats, and in the smaller quantity of fuel necessary for 100 hours' steam.

The loss caused by this decrease of cargo-carrying capacity may be expressed in dollars, the assumption being made for this case, as for all former calculations, that the ships are plying in Dutch waters, under conditions of freight and prices usual in Holland. The mean length of voyage is taken to be fifty hours, giving $1 freight per ton, as is the case in several trades. The 120-ton gas boat loses 3½ tons = $3.50 per voyage = $7 per 100 hours. The 300-ton steamship loses 17 tons = $17 per voyage = $34 per 100 hours. These losses should be added to the working costs, which gives the following results:

116-TON GAS BOAT VS. 120-TON OIL BOAT.

	1,100 Hours Yearly.		1,800 Hours Yearly.	
Yearly Cost for	Gas.	Oil.	Gas.	Oil.
Engine	$460	$244	$513	$275
Fuel	110	477	178	780
Cargo loss	77	...	126	...
Total outlay.	$647	$721	$817	$1,055

823-TON GAS BOAT VS. 300-TON STEAMER.

	1,100 Hours Yearly.		1,800 Hours.		3,000 Hours.	
Yearly Cost for	Gas.	Steam.	Gas.	Steam.	Gas.	Steam.
Engine	$1,569	$1,095	$1,569	$1,095	$1,569	$1,095
Fuel	300	590	510	965	850	1,610
Cargo loss	....	374	....	612	....	1,020
Total outlay....	$1,879	$2,059	$2,079	$2,672	$2,419	$3,725

It will be seen that the result is depending to a great degree on conditions of yearly sailing, hours, full prices, etc. To judge on the advisability of fitting gas, steam or oil engines in a given ship for a given trade, an exact calculation should be made, taking into consideration the following points: Fuel consumption, fuel prices, yearly sailing hours, engine prices, freights and engine weights.

HYDROGEN IN THE GAS MIXTURE.

From the editorial comment in the October issue it appears that some American engineers are not convinced of the advantage of introducing hydrogen into the gas mixture of suction gas plants.

First of all may be pointed out the practice in Germany, as in no country has the suction-gas industry developed to such an extent. The fact is that, without any exception, the general practice is to introduce hydrogen into the mixture.

A well-known authority on these questions may be quoted, viz.: Hugo Güldner, author of that unique work *Das Entwerfen und Berechnen von Verbrumingo motoren.* On pages 518, 519, 533 and 586 he writes:

"In the power gases carbonic oxide and hydrogen are the real combustible elements. For the motoric combustion both of them have good and bad qualities, which should neutralize each other in the mixture. The question: Does the motor manufacturer want more *CO* or more H_2 in the gas mixture? is answered by Kutzbach in the following way: (*Zeitschrift des Vereines Deutscher Ingeneure,* 1905, page 238.)

"Hydrogen, when compared to carbonic oxide, appears to have the following qualities:

"1. Its igniting temperature is considerably lower.

"2. Its igniting velocity is thirty times as great.

"3. It mixes with the air more rapidly.

"4. It will still burn in an abundance of air where *CO* will not burn any more."

The presence of *H,* therefore, decides on the form of the diagram and on the highest allowable temperature of the cylinder liner; small variations in the quantity of *H* are of great influence on the igniting velocity and so on the motor power. The motor manufacturer, therefore, says: "Not too much *H,* to prevent the engine getting too sensitive; not too little *H,* to assist the slow *CO,* which will occasionally burn so slowly as to give diagrams of triangular form. Sometimes it is still burning when the exhaust is done and new gas is admitted, igniting this and thus causing violent explosions.

Power gases from coke and anthracite, respectively, are constituted as follows: (E. Meyer, *Zeuitscr. d. V. D. T.,* 1895, page 1540; 1896, pages 1239 and 1304.)

PERCENTAGES OF THE VOLUME.

	Coke.	Anthracite.
CO	27.6	16.6
H	7	24.2
CO_2	4.8	11.3
CH_4	4	2
N	58.6	45.9
	100	100

The heating power of these different elements in 1 cubic

meter (35 cubic feet) of anthracite gas of a commonly-used mixture is as follows:

	Percentage of the Volume.	Calories.	Percentage of the Heating Power.
CO	23	700	56
H	18	465	37.2
CO_2	6	0	....
CH_4	1	85	6.8
N	52	0	....
	100	1,250	100

Apparently the hydrogen has a great influence on the heating power of the gas, especially in anthracite gas; which may contain as much as 24 percent *H*, more than half the heating power may be given by the hydrogen.

Thus it is *theoretically* proven that it is advantageous to introduce a great quantity of steam into the producer. *Practically* it is profitable, too, because it prevents the baking of slags and the burning through of the internal-firing apparatus.

Too high a percentage of *H*, however, causes violent explosions in the cylinder. Very few motors can endure 15 to 20 percent *H* in the gas; that is, 7 to 10 percent in the gas-and-air mixture which enters the cylinder; usually a troublesome knocking begins at 10 percent *H* in the gas. Moreover, the reduction of H_2O to H_2 and O_2 takes a good deal of heat, which means a decrease in temperature in the producer, thus favoring the forming of CO_2 at the cost of *CO*. Higher percentage of H_2 thus always means more CO_2 and less *CO*, which may be seen, too, from the table above.

The best plan for every individual motor is to give as much water to the producer as the motor will endure.

The objection that the burning of H_2 to H_2O in the cylinder may form drops of water that may settle on the igniter, and so prevent the ignition, is answered best by pointing to the fact that H_2O formed always leaves the cylinder as steam. (Güldner, page 580.) Only when the cylinder liner is still cold at starting might water condense on the igniter. To prevent this the motor should be started on gas without hydrogen, and only when the motor has been going for some time should the water and steam cocks leading to the producer be opened.

Institution of Naval Architects.

The 1910 session of the Institution of Naval Architects was held in the hall of the Royal Society of Arts, John street, Adelphi, March 16, 17 and 18. The following papers were read and discussed:

MARCH 16.

"The Battleship of the Future," by Rear Admiral R. H. Bacon, D. S. O., C. V. O. Associate.

"Report on the Progress of the National Experimental Tank," by R. T. Glazebrook, D. Sc. F. R. S.

"An Account of the Society for the Improvement of Naval Architects," by A. W. Jones, R. C. N. C. Member.

MARCH 17 (MORNING SESSION).

"Experimental Investigations of Weight and Thrust Deduction Values," by W. J. Luke. Member of Council.

"Some Considerations Regarding the Phenomena of Propulsion," by Prof. J. B. Henderson, D. Sc.

"Model Screw Propeller Results: a Comparison," by T. B. Abell, R. C. N. C.

"A New Method of Ascertaining the Weight of Cargoes on Board Ship," by A. Murray. Member.

EVENING SESSION.

"Motor Life Boats of the Royal National Lifeboat Institution," by J. R. Barnett. Member.

"The Application of Internal Combustion Engines to Fishing Boats and Other Commercial Launches," by Linton Hope. Associate.

"The Substitution of the Electric Motor for Marine Propulsion," by W. P. Durtnall.

MARCH 18.

"The Application of the Marine Steam Turbine and Mechanical Gearing to Merchant Ships," by Hon. C. A. Parsons, C. B. F. R. S., D. Sc. Vice-president.

"Note on the Measurement of Shaft Horsepower," by Prof. B. Hopkinson, M. A. D. Sc. Associate.

"The Brittleness of Mild Steel Due to Nitrogen," by C. E. Stromeyer. Member of Council.

Lubrication of Marine Steam Engines.

In one of the recent issues, a correspondent wonders how marine engines can be run without cylinder oil and not injure the cylinder walls or piston packing.

There is not a boat in the United States navy, from the battleship down to the 30-foot launch, that uses cylinder oil or compound, direct to the cylinder or valve chamber, either in the main engines, or auxiliaries, ventilating, force-draft, reversing. The piston rods on the main engines are swabbed at regular intervals, not with the idea of getting oil into the cylinder, but to save the packing in the stuffing-box and keep the rods tight. When a ship anchors for over a week in port, it is customary to remove cylinder heads and valve-chest covers, and swab the bearing surfaces with vaseline.

If the main engines are fitted with D-slide valves, of the ordinary or double-ported type, they are, as a rule, if large and heavy, connected to a balanced piston on top. This balance chamber is practically an inverted dashpot, with the bottom of the piston exposed to the atmosphere, whereas the clearance on top of the piston is connected to the condenser. The average vacuum carried is 26 inches. This balanced chamber is designed large enough to remove the "dead" weight from the eccentrics and link block.

To reduce the excessive friction on the valve space, with this type of valve, there is fitted on the back of the valve a brass or composition ring, secured in such a manner as to be steam-tight on the back of the valve at all times. The inside of the ring is connected to the condenser by a small pipe. In the United States navy, steam, in itself, is sufficient lubrication for internal wearing surfaces.—F. Caldwell in *Power and the Engineer.*

New Steamers in New York Harbor.

The Walters-Colver Company, West Brighton, Staten Island, N. Y., have on their building ways two new steamers for the City of New York, Department of Correction. The hull of the *Riker Island,* the first of these two, is about completed, and the launching will take place shortly. The *Riker Island* will be a wooden vessel throughout, 81 feet on deck, 75 feet 10 inches on loadline, 20 feet beam and 8 feet depth of hold. She will have a draft of 5 feet, and develop a speed of 12 miles an hour. This steamer will be equipped with a flue and return-tubular boiler, carrying 150 pounds pressure per square inch; a vertical inverted compound surface condensing engine, with cylinders 9 inches by 20 inches diameter by 16 inches stroke, designed to develop 225 horsepower. The vessel will be lighted throughout with electricity.

The second steamer is to be called the *Hartz Island;* length on deck 72 feet, on loadline 65 feet, width 17 feet, and depth of hold 8 feet, with a draft of 4 feet 6 inches. She is designed to develop a speed of 12 miles an hour. Her boiler and engine will be similar to those of the *Riker Island,* but somewhat smaller, and designed to develop 150 horsepower. Both the *Riker Island* and the *Hartz Island* are to be used for passenger and freight service between the various institutions connected with the Department of Correction.

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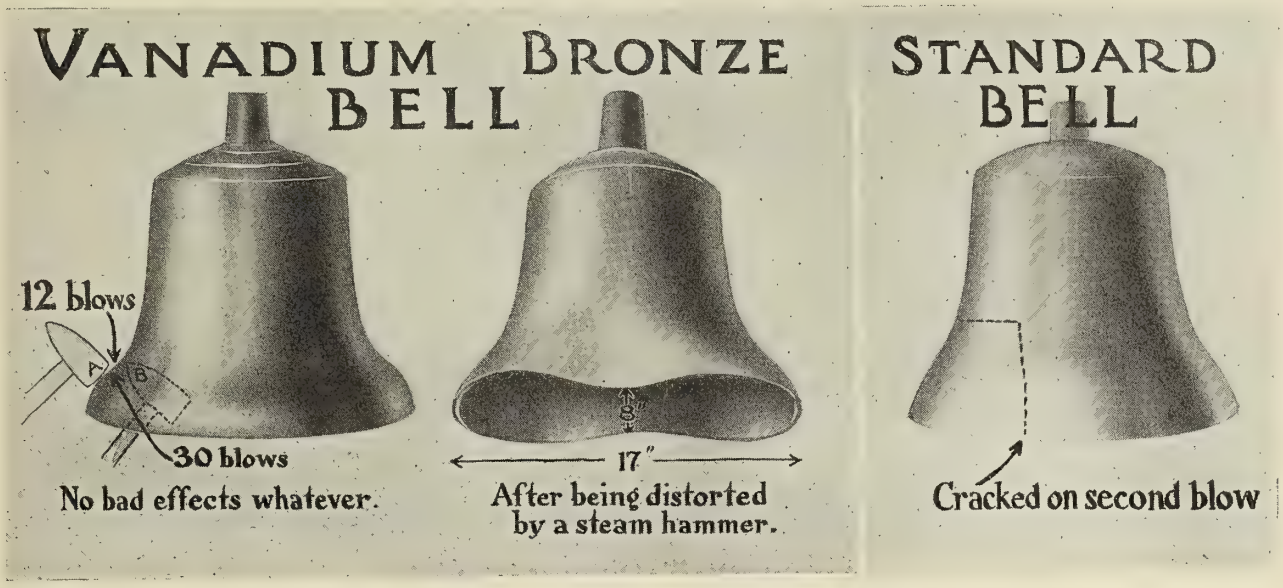

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"In response to your request would advise that the six sample Vanadium Bells have been received, machined up and proved very satisfactory.

"After mounting and testing for sound, we determined that these bells have a clearer and much better tone than any bell which we have heretofore examined.

"The physical test of these bells showed remarkable results and were superior in every respect to the bells made from our own mixture, 82% Copper and 18% Tin.

"The Vanadium Bell was struck 12 blows with the face end of a sledge hammer at 'A' (as marked in above sketch) without any evidence of failure. It was then struck 30 blows at 'B' without any evidence of failure. The bell was then placed under the steam hammer and distorted in the shape shown in above sketch without any evidence of failure.

"The bell made from our standard mixture was struck 12 blows with the face end of a sledge hammer at 'A' without any evidence of failure. It was then struck twice at 'B' with the peen end of the sledge and cracked at the second blow. The bell really cracked with one blow, as the first blow scarcely nipped the edge of the bell, while the second bow, which was a true one, cracked the bell to the extent shown in sketch No. 2." 1

Write for our booklet on "Vanadium Metals in Marine Construction."

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PRACTICAL EXPERIENCES OF MARINE ENGINEERS.*

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries Breakdowns at Sea and Repairs.

Repairs to a High-Pressure Piston Rod.

On Oct. 19, 1909, the U. S. S. *Annapolis* returned to port after a hard run in a gale with heavy seas, and a heavy knock developed in the high-pressure engine. Upon investigation it was found that the threaded end of the high-pressure piston rod, which screwed into the cross-head, had become so loose and worn that it could not be made tight again by the clamping bolts. As there was no spare rod available, the following repairs were made (see sketch).

A taper hole having been bored in the end of the piston rod to nearly the entire depth of the thread, a finished steel plug of the same taper was fitted to within 1½ inches of the bottom of the hole. This plug was a few inches longer than the depth

THREADED PORTION OF PISTON ROD WITH TAPER PLUG INSERTED.

of the hole to facilitate its extraction. The rod was now heated slightly over a charcoal fire and the plug driven home. This expanded the threaded end of the rod 1/32 inch.

Having extracted the first plug, a second plug finished to the new taper in the rod was fitted to within 1½ inches of the bottom of the hole and again driven home and allowed to remain in place while the rod was cooling. This plug was then faced off and secured by two set screws. The second operation expanded the rod another 1/32 inch, so that the diameter of the rod was now increased 1/16 inch, which was found sufficient to refit the thread and make it tight in the cross-head.

After the repaired rod was installed, work was commenced at once to manufacture a new high-pressure piston rod. A bar of machinery steel 6¼ inches in diameter was used. A piece 4 feet 6 inches long was hack-sawed off, put in the lathe on board the ship and a new rod was successfully turned down, tapered and threaded ready for use by the ship's force in 64 hours.

John F. Green,
Machinist, U. S. N.

Tutuila, Samoa.

Loss of Vacuum in a Marine Condenser.

The usual causes which lead to a loss of vacuum in a condensing engine are well known to the ordinary marine engineer, and the most usual points to which he is accustomed to look in the event of a partial or total failure of vacuum are leaky cylinder glands, broken air-pump valves, broken circulating pump valves, cracked castings, which allow air to enter into the condenser, and leaky joints between the condenser and pumps. These and other causes produce by far the greatest number of failures of vacuum, and their treatment is a matter of standard practice.

It has, however, been known that engineers have occasionally had a greatly reduced vacuum and have naturally gone over all the above defects without finding anything wrong. It may be worth pointing out that such failures sometimes occur through deterioration in the condenser itself. As a last resource it is advisable to examine the division plate in the water-box of the condenser, as it is sometimes found that this has been partly or wholly carried away, and consequently the water, instead of passing through the tubes, goes straight through the water-box from inlet to outlet, and therefore the tubes of the condenser are surrounded by stagnant water, which rapidly becomes so hot as to have no effect upon the steam passing.

This trouble is, of course, a rather serious matter, but a temporary repair can very easily be accomplished by fixing and shoring a wooden division plate made of a plank of soft wood about 2 inches thick and a length equal to the horizontal width of the interior of the water-box at the point where the division plate should be. It will be found that by firmly choking this in the first instance the water will cause it to swell and make it fit tighter, if anything, than ever before. This repair is, as a matter of fact, sufficiently good to be permanent, as the duration of life of wood under such circumstances is long. It is advisable, however, to obtain a new condenser cover with a new division plate at the end of the voyage. The repair is, however, worth mentioning, as it only takes at the outside 30 minutes to effect it, and it will give no further trouble throughout the voyage.

Glasgow. Bert Hall.

Crosshead Troubles.

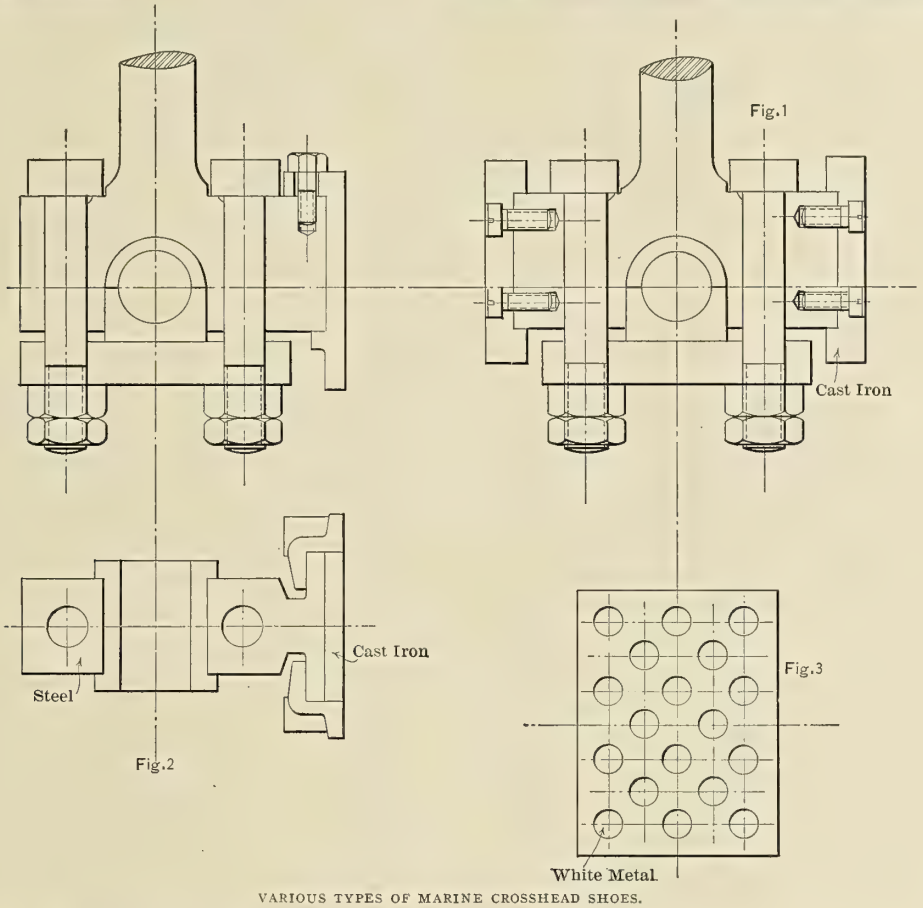
The crosshead shoes of marine engines do not give much trouble, and when the rubbing surfaces are well lubricated they do not require much attention. Formerly crossheads were usually provided with brass shoes, but now, as a rule, the slippers are of cast steel, lined with white metal, which is quite satisfactory, though good results may also be obtained when the shoes are of cast iron, thus making both of the rubbing surfaces cast iron. The latter arrangement requires more oil than white metal on cast iron, but it wears less. Frequently, however, cast iron will give trouble where white metal will not, as evidenced by the following incident:

The crossheads of the compound engine of the steamer *W* were constructed as shown in Fig. 1, the cast-iron shoes running on cast iron guide plates. On the trial trip the crosshead warmed up, as too little oil was used on the rubbing surfaces. It was found impossible to cool the crosshead by using as a lubricant oil mixed with white lead, which is usually found an excellent help when a bearing or sliding surface is heated. The crosshead soon became so hot that sparks could be seen on the guide plates, and, after some revolu-

* We pay for these articles.

tions, the engines stopped entirely. It was found necessary to take off the shoes, which proved a rather laborious job, since it was necessary to take the cylinder cover off and unscrew the piston, in order to lower the rod below the sliding plate, so that the screws which fastened the shoes could be loosened. After this was done several hard places were visible on the shoes and these were cut away. Subsequently everything was put back in place and the engine again started. The same shoe has given the same trouble three or four times since then.

From the foregoing it is evident that this form of crosshead is not the best one, since once it becomes warm it will swell and the friction will then be greater, so that the temperature will again become higher and so on till the crosshead grips between the columns.



VARIOUS TYPES OF MARINE CROSSHEAD SHOES.

After this experience the builders of these engines lined the shoes with white metal on both sides. This effectually did away with the heating of the crosshead, but the wear was greater, so the construction finally arrived at was to line the astern shoe only with white metal. This prevented the crosshead from gripping, but, at the same time, the wear was small.

Cast iron on cast iron in the form indicated in Fig. 2 gives no trouble, but many engine builders object to it and pour white metal in the shoes flush with the cast iron, as shown in Fig. 3. This is not at all necessary, but in settling the question of whether white metal should be used or not, the possible damage should be considered if the rubbing surfaces should grip, and it must be borne in mind that this cannot occur if one of them is lined with white metal.

The writer knows of at least one case in which the eccentric rings were not lined with white metal. On the trial trip of the vessel one of them gripped on the eccentric sheaves, causing the breaking of the drag rods and drag rod lever and the bending of the valve rod. The links with the rods fell down on the floor plates, which were damaged, and the eccentric rods were also bent. The builder of this engine always after this lined the eccentric rings with white metal.

Cases are seldom found where cast-steel slippers are running on cast-iron guide plates, but the writer knows of several engines in which this construction is used, and it may be strongly recommended, as it has never given any trouble. For crossheads of the shape shown in Fig. 1, it is, of course, necessary to use white metal on the astern side. D. K.

Internal Feed Pipes.

The boiler of a small tug (an ordinary Scotch, with a single furnace) had been troublesome for a long time through priming badly—almost continuously with dirty or sea water. The main check valve was on the front of the boiler at about the level of the center line of the furnace and had no internal pipe, the boiler being too small for a man to get down between the tubes and shell to fit one.

The valve was taken from the front and fitted on the back of the boiler and an internal pipe fitted, with one row of holes having about 25 percent more area than that of the pipe. The pipe was fastened so that the *water was delivered towards the front or smoke-box end of the boiler.* We found the position of these holes a very important matter, as by giving the cross-pipe half a turn, to make it discharge towards the combustion chamber, the boiler primed again so much that the boat had to pull up, and we had to lower the steam and fix the pipe to discharge as at first. Ever since it has been found to be practically impossible to make her prime.

In another steamer, the check valve was on the side of the shell, about level with the third row of tubes from the top—no internal pipe was fitted. As there was always a certain amount of dirt among the tubes opposite the check, we de-

cided to fit a pipe similar to the first case; and on opening the boiler about ten weeks afterwards we were pleased to find it much cleaner than usual everywhere (the engineer said dirt had shifted that he had been trying to get rid of ever since joining the ship), all the loose dirt being heaped up on the bottom of the shell at the back end, as shown in Fig. 1.

In several steamers having to make up with river water, which is always more or less dirty, and makes a lot of hand-scaling necessary, their internal pipes were altered to the plan described above, and in every case the result was the same; the boilers in a few months becoming uniformly clean everywhere, and all the loose dirt being found heaped up at the back end of the bottom of the shell.

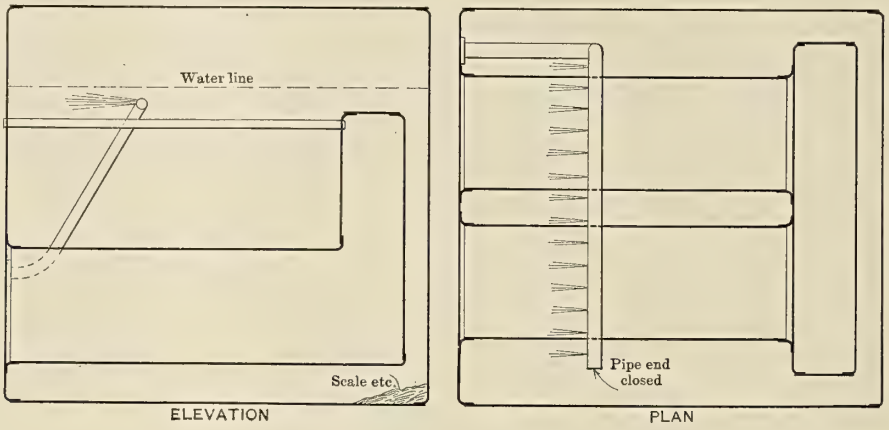


FIG. 1.

Of course an internal feed pipe is no novelty, most steamers now have them, but its arrangement is deserving of a little more study than is usually bestowed upon it. In the previous examples, each pipe as originally fitted was discharging, so that the circulation was checked instead of assisted, and when the boilers were emptied a lot of hard scaling was always done, but after fitting the pipe as shown in Fig. 1, hardly more than a brushing out was required. I think the best place for the cross-pipe is a little less than half the length of tubes from the front end.

For a double-ended boiler, something like the arrangement shown in Fig. 2 would be suitable; and it will be found that the result obtained will fully repay the expense of fitting. It is necessary to see that plenty of well-fitting hangers are used to support the pipes. Drazit.

New Zealand.

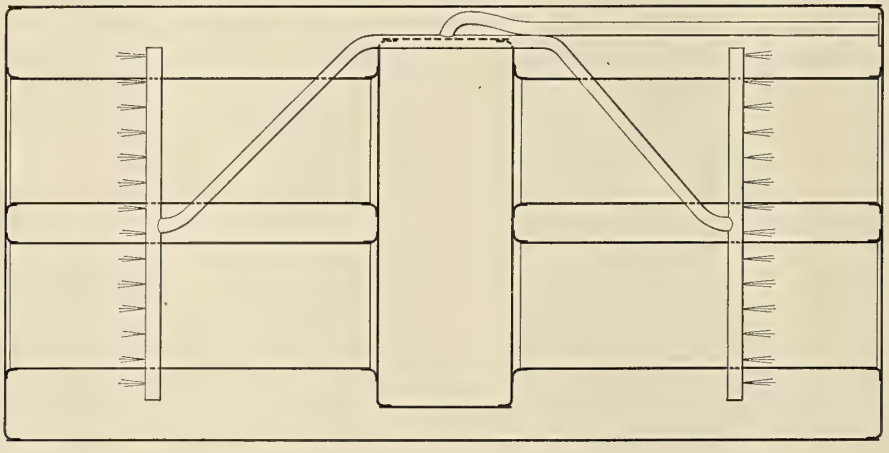


FIG. 2.

A Broken Injection Pipe.

It is not altogether an easy matter in making repairs in a marine-engine room, where space is very restricted, and very often time is precious, to exercise the right amount of care in order to secure that no damage is done during the operation. In one instance, the engineer on board a vessel had been overhauling the condenser, and was putting the door on, when the chain sling on which the door was hanging snapped, and the door came down suddenly, struck the copper injection pipe, and stuck there. As it was impossible to take the pipe out and send it ashore in order to have a patch put on, the position was a bit serious. There was a very nasty gash in the pipe, passing three-quarters of the way round its circumference and measuring about 1½ inches in width. As the pipe was 12 inches diameter, it was a job which required a certain amount of care in handling in order to effect a working repair. In order to allow the ship to proceed on her voyage the gash in the pipe was, first of all, lapped with canvas, so that the gap was completely covered all the way round, with a wide margin on either side. A box cradle was then made so as to go round under the pipe and passing well up the sides, a clearance of 3 inches all round the pipe being left. Into this space was run a mixture of Portland cement, with a bit of soda in it in order to stiffen it, and in a short time there was a solid 3 inches of cement round the gash. So well did this repair succeed that, although it was only regarded, at first, as a temporary expedient, it was allowed to remain in place, and, as a matter of fact, has been in continuous service for over three years since the unfortunate accident occurred. A. H. S.

Repairs to a Broken Thrust Shaft.

While the Red D Line steamship *Zulia* was running from Maracaibo, Venezuela, to Curacao one of her thrust shafts broke just aft of the after ring in the backing thrust block. The mishap occurred at 3:20 A. M. on a Sunday morning while the second assistant was on watch. When the break occurred, it was supposed that the propeller had momentarily lifted out of water and caused the racing of the engine, but a few seconds showed that something worse had happened, and only quick action on the part of the second assistant saved the engine from damage.

The broken shaft was blocked up as soon as possible, and the vessel proceeded to Curacao with but one propeller working. Preparations were immediately made to repair the broken shaft in order to enable the vessel to complete her homeward voyage to New York, with the loss of the least possible amount of time.

There are four rings on the backing thrust and six rings on the go-ahead thrust. The break, as previously stated, occurred just aft the after ring in the backing thrust, and was due to an old crack in the shaft, which left only about 3 inches of metal in the center of the shaft to transmit the load. The shaft was broken off almost as squarely as if it had been severed with a hack saw.

The backing-thrust block was first removed and the last collar drilled off. Then two keyways, 8 inches long and 1¾ inches wide, were cut in opposite sides of the shaft. Cutting off the collar and cutting the keyways took all hands about four days working 24 hours a day. An old thrust ring from another ship was secured at Curacao, but this was 6½ inches inside dinameter, while the shaft of the *Zulia* was 7¾ inches diameter. This ring, therefore, was chipped out with a hammer and chisel to fit the shaft of the steamship *Zulia,* and two keyways were cut in the ring at the top and bottom to correspond with the keyways in the shaft. It was also necessary to cut the sole plate to clear the bolts on the ring. The oil box was cut off the steady bearing aft the break and a clip of ¾-inch iron was placed around the shaft and secured with four ⅞-inch follower bolts against the steady bearing to give security in case the repairs should give way.

Four holes for ¾-inch studs were drilled into the ring at the aft end of the shaft, and the studs driven into the shaft through the ring and into the shaft a distance of 1¼ inches. At the forward end of the break two holes were drilled for ¾-inch studs through the ring and shaft, and the second collar on the shaft was drilled through for a 1-inch stud in order to hold the ring in place.

It took from 8 P. M. Sunday until Friday evening to complete the repairs. The vessel sailed from Curacao to Laguayra, Venezuela, a distance of 196 miles, and arrived the following evening at 7 P. M. As the port was closed, she cruised around all night, and the following morning loaded her cargo and left Laguayra on Monday, arriving at New York on Thursday, March 10, a distance of 1,860 miles. During this time the engines were not stopped, nor was the repaired shaft touched. The engine was run at practically full power and the weak shaft was not favored. Of course, with the backing thrust block out of commission, this engine could only be run ahead. When it was necessary to reverse, the other engine had to be depended upon.

This is one of the cleverest repair jobs which has been executed recently, and reflects much credit upon the chief engineer, and his assistants, who carried out the work under such difficult circumstances. The engine-room staff which accomplished this work included Harry Stout, chief engineer; P. Burns, first assistant; W. Brown, second assistant; E. Johnson, third assistant.

The *Zulia* is a twin-screw steamer of 1,713 gross tons, built in 1901 by the Neafie & Levy Ship & Engine Building Company, Philadelphia, Pa. Her main engines consist of two sets of three-cylinder, triple-expansion, vertical inverted engines, with cylinders 14, 21 and 36 inches diameter and 26 inches stroke, aggregating 1,360 indicated horsepower. Steam is supplied at a working pressure of 160 pounds per square inch by two cylindrical-return tubular boilers, 12 feet 3 inches diameter and 12 feet 7 inches long. The boilers have a grate surface of 63 square feet, and a heating surface of 1,840 square feet.

A Broken Junk Ring.

The junk ring of a piston must be very stiff, so that the ring cannot bend when the junk-ring bolts are tightened up, as then the packing rings will have too much room and can move on the piston in an up-and-down direction. Junk rings are thus of ample strength for their work, and a case is seldom heard of where they have been broken.

On the tug *A* the drain pipes from the drain cocks in the bottom of the high-pressure cylinder and high-pressure valve chest were led to a feed tank and terminated there below the water level. These cocks should, of course, be shut after they have drained the cylinder and valve chest. This was forgotten after the stopping of the engine one night, the steam in the cylinder condensed, forming a vacuum, and then the water from the tank was pressed by the atmospheric pressure into the high-pressure cylinder. On starting the next morning the cylinder drain cock was opened too late, and the piston struck on the water. The piston body being smaller than the cylinder, a great force was exerted on the packing ring, and so on the junk ring, which broke radially through the bolt holes.

To make it possible to continue the journey, the high-pressure connecting rod was disconnected, and the piston and steam valve were removed. The valve stem was disconnected from the link block and the piston rod and valve stem fixed in the stuffng boxes, so as not to have any steam passed from the high-pressure cylinder, and then the cylinder and valve chest cover were put in place.

The engine was then started again, the live steam, reduced in pressure by a stop valve, being admitted to the intermediate-pressure cylinder. This starting was very difficult, as the cranks of this engine (compound) naturally were placed at 120 degrees. It ran, however, very regularly, and, as the captain took care not to stop the engine until the engine works were reached, no more difficulties were met. D. K.

Clyde-Built Brazilian Destroyers.

The torpedo boat destroyer *Alagoas,* one of ten destroyers ordered by the Brazilian Government from Yarrow & Co., and built by them at their Scotstoun yard, near Glasgow. The official full-speed trial took place in November on the Skelmorlie measured mile at the mouth of the Clyde during boisterous weather. The contract speed of 27 knots for three hours was easily obtained, carrying a load of 100 tons. The *Alagoas* is 240 feet long by 23 feet 6 inches beam. She is propelled by two sets of four-cylinder reciprocating engines of 8,000 horsepower, collectively, balanced on the Yarrow Schlick and Tweedy system. Steam is supplied by two double-ended Yarrow boilers of the latest type.

Six destroyers, built by Yarrow & Co., viz., the *Para, Piauhy, Amazonas* and *Matto Grosso, Rio Grande de Norte,* and the *Parahyba* have already gone out to Brazil. The firm have still three similar vessels under construction, viz., the *Santa Catharina, Parana* and *Sergipe.* These are nearing completion.

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Oil Fuel.

During the last few years the mechanical difficulties encountered in the use of oil for fuel on steamships have been practically overcome, so that its extensive adoption is now a question principally of the available supply and the relative cost of oil and coal. A comprehensive discussion of these two points is published elsewhere in this issue, and those who have not investigated these questions carefully will, undoubtedly, be surprised at the possibilities for obtaining a large supply of fuel oil at a reasonable price in the near future.

From statistics gathered by our correspondent, the total production of fuel oil in the world in 1904 was 219,000,000 barrels, of which the United States produced 53.4 percent, and Russia 35.82 percent. Comparing oil and coal on a basis of heat units the production of oil in the United States in 1906 was 7 percent as much as the production of coal. When it is considered that coal is largely used for industrial purposes for which oil, either on account of its inaccessibility or its properties as a fuel, could not be used, it is evident that the supply of oil in the United States is abundant for marine work. Furthermore, due to the fact that oil can be so easily transported by pipe lines and tank steamers, it can be delivered to any port in the country at a reasonable price, and since it is possible for a steamship to carry enough oil for a complete voyage to any part of the world and return, the practicability of its use as fuel in American naval and merchant vessels is evident. Not only is the present supply adequate, but the development of oil fields is practically in its infancy, and the possibilities for future development in this direction, both in the United States and in foreign countries, are great. It is probable that in the near future India will become a great producer. There are indications of large resources in various South American countries, in Turkey, Armenia, Africa and Persia, and in America future developments may be expected in Newfoundland and Labrador, Alaska, Mexico and Cuba. On the Pacific Coast of the United States coal is practically out of consideration as a fuel for industrial purposes, both ashore and afloat; oil has entirely supplanted coal ashore and has practically done so for marine work.

To compare coal and oil with reference to their economical use as fuel is difficult in many cases, since the calorific value of coal varies from 9,000 to 14,000 B. T. U.'s per pound, and since the availability and quality of both fuels in different parts of the world affect the price enormously. In general, however, it has been found that one pound of petroleum does the work of a pound and a quarter of coal and occupies 40 percent less bunker space. With oil fuel, the capacity of a boiler plant can be increased about one-third, or a given power may be obtained on about 25 percent less boiler capacity. One authority has stated that the difference in fuel consumption in favor of oil as compared with coal is about 33 percent, and that the saving in weight would permit an increase of about 50 percent in the steaming radius of a vessel. The principal advantages of oil as a fuel, aside from a saving in weight and space, are: Saving in labor (since the fire-room force can be cut to less than a quarter of that required for a coal-burning vessel); ease in handling and storing the fuel; speed in fueling a vessel; increased speed, due to the maintenance of steady fires and higher steam pressures; elimination of the cleaning of fires and the handling of ashes, and increased life of boilers (due to the constant temperature maintained). To offset these advantages there is the danger of explosion and accident, due to the use of oil; the loss of fresh water used in atomizing the fuel or the increased steam consumption if air is used for atomization; and the additional cost of auxiliary apparatus necessary to handle the oil, heat it and atomize it. The dangers attendant on its use can, of course,

be minimized by care in the construction and location of the oil tanks and in the selection of the oil. The minimum flash point for fuel oil for marine work is usually stated as 150 degrees, while the maximum moisture is 1 percent and the maximum sulphur ½ percent. The calorific value averages 18,000 B. T. U. per pound, and the specific gravity 15 and 17 degrees Beaume. The loss of fresh water, where steam is used to atomize the oil, varies from 1 to 4 percent of the total steam generated and necessitates a corresponding increase in the size of the evaporating plant.

It is only fair to say that the mechanical difficulties encountered in burning oil are well in hand. For marine work the method of burning oil is practically limited to atomization by steam or air, and since the former is wasteful of fresh water, it is probable that vessels on long voyages will be limited to air atomization.

The use of oil fuel for naval vessels is rapidly increasing, and, from a strategic point of view, the United States should take the lead in this respect. Already exhaustive experiments have been made by the Bureau of Steam Engineering, with the result that new oil fuel depots are to be established on both the Atlantic and Pacific Coasts, and in future provision will be made to insure an adequate supply of oil for naval purposes.

Development of Inland Waterways.

The development of inland waterways, such as the improvement of rivers, the digging of canals and the erection of warehouses, docks and freight-handling appliances at terminals, has been carried to a much greater extent in Belgium, Holland, Germany, France and Great Britain than it has in America. Many American writers are urging that far more attention be given to this subject by the federal government as well as by the different States. Nothing would be more gratifying to International Marine Engineering than to see a comprehensive plan started immediately for great improvements, especially in rivers in all parts of America. Undoubtedly in the near future the building of canals will not only be desirable but necessary.

Just at present, however, the prospect is not as bright as we wish it were, purely from the fact that the carriage of freight on American railways is much lower than in any of the other countries mentioned. One of the leading American experts on canal transportation recently compiled some figures as to the cost of transporting coal from Cumberland, Md., to New York City, by railroad, and also by water. The rates used in estimating the cost of transportation by railway were the actual charges as shown by the tariff sheet, whereas the estimated rates for canal tolls and other waterway charges were those now made on the canals of Belgium, which, we believe, are the lowest in any nation. The railroad charges per ton mile were almost exactly those of the water rates on the Belgium basis. Considering the fact that railroads are in operation twelve months in the year, whereas a considerable proportion of the waterways between Cumberland and New York are closed by ice four or five months in the year, the prospects for canal development are certainly not bright at present. There is, however, great demand for developing coastwise and local traffic, as well as the river traffic, in all parts of the United States, and the attention needed to carry out these improvements ought to be sufficient to keep our engineers busy for many years to come if the government will only undertake the work on a sufficiently comprehensive scale.

Internal Combustion Engines.

The internal-combustion engine for marine work has reached an interesting stage of development. In small sizes, suitable for use in motor boats, the internal-combustion engine using gasoline (petrol) as a fuel is supreme. Its weight is only about one-half that of a steam plant of the same power, and the weight of fuel used is about one-quarter of that necessary for the steam plant. Just as soon, however, as the size of the engine is increased to several hundred horsepower the cost of gasoline (petrol) becomes prohibitive for most purposes, and it is necessary to turn to some other fuel. The choice then lies between some form of petroleum or crude oil and producer gas generated from either coal or oil. Undoubtedly the field for heavy oil engines will, in the near future, be one of the largest in marine work. Certain types of oil engines require neither the electric nor open-flame ignition, and are, therefore, reduced to the simplest form possible for an internal-combustion engine, making them very valuable for use in fishing boats and for other commercial purposes where they must be operated by unskilled labor. Before producer gas comes into extensive use the first cost of such an installation must be very materially reduced in order that it may compete successfully with steam plants. Producer gas permits a direct gain in fuel economy over a steam plant. This fact has been established by the results obtained with hundreds of shore installations and also by the few experimental marine plants which have so far been made. Economy in fuel consumption, however, is only one consideration in the cost of a power plant, and any advantage derived from it can easily be lost if the first cost of the plant is excessive. Practically the only other fuels that give the internal-combustion engine an opportunity to compete in economy with steam are residuum and crude oil. The more refined grades of petroleum are too expensive. From the standpoint of economy, then, as compared with steam, the development of the internal-combustion engine is only just beginning, and the future possibilities in this field are great.

Progress of Naval Vessels.

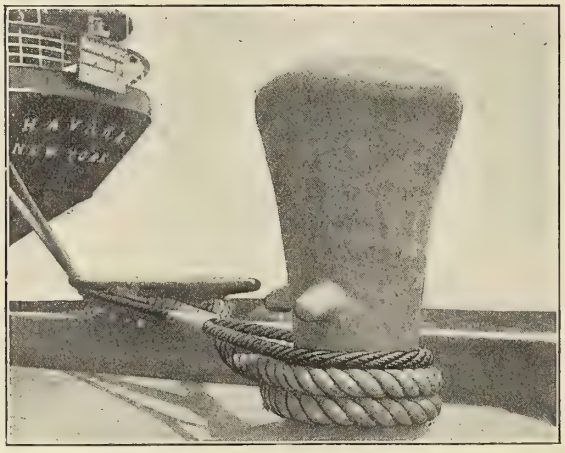
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Feb. 1.	Mar. 1.
BATTLESHIPS.					
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	99.5	100.0
North Dakota	20,000	21	Fore River Shipbuilding Co..	98.6	99.1
Florida	20,000	20¾	Navy Yard, New York.....	50.5	55.2
Utah	20,000	20¾	New York Shipbuilding Co...	62.2	65.2
Arkansas ...	26,000	20½	New York Shipbuilding Co...	11.2	12.5
Wyoming ..	26,000	20½	Wm. Cramp & Sons.....	9.0	16.9
TORPEDO-BOAT DESTROYERS.					
Paulding ...	742	29½	Bath Iron Works.....	64.6	71.8
Drayton	742	29½	Bath Iron Works.....	59.9	67.4
Roe	742	29½	Newp't News Shipbuilding Co.	73.0	77.2
Terry	742	29½	Newp't News Shipbuilding Co.	72.1	76.6
Perkins	742	29½	Fore River Shipbuilding Co..	65.3	65.8
Sterrett	742	29½	Fore River Shipbuilding Co..	65.0	65.6
McCall	742	29½	New York Shipbuilding Co..	48.1	53.4
Burrows	742	29½	New York Shipbuilding Co..	48.1	53.4
Warrington..	742	29½	Wm. Cramp & Sons.....	60.3	62.7
Mayrant	742	29½	Wm. Cramp & Sons.....	60.9	64.9
Monaghan ..	...	..	Newp't News Shipbuilding Co.	10.1	14.8
Trippe	...	..	Bath Iron Works.....	18.4	22.9
Walke	...	..	Fore River Shipbuilding No..	11.9	14.0
Ammen	...	..	Fore River Shipbuilding Co..	12.4	14.6
Patterson ...	...	..	Wm. Cramp & Sons.....	9.1	10.7
SUBMARINE TORPEDO BOATS.					
Salmon	...	..	Fore River Shipbuilding Co..	90.6	91.0
Seal	...	..	Newp't News Shipbuilding Co.	36.6	45.4
Carp	...	..	Union Iron Works.....	39.1	43.3
Barracuda ..	...	..	Union Iron Works.....	39.1	43.1
Pickerel	...	..	The Moran Co.....	36.9	40.25
Skate	...	..	The Moran Co.....	36.9	40.25
Skipjack	...	..	Fore River Shipbuilding Co..	16.8	31.3
Sturgeon ...	...	..	Fore River Shipbuilding Co..	16.6	30.9
Tuna	...	..	Newp't News Shipbuilding Co.	14.0	19.8
Tuna	...	..	Wm. Cramp & Sons.....	0.0	3.1

ENGINEERING SPECIALTIES.

Durable Wire Rope.

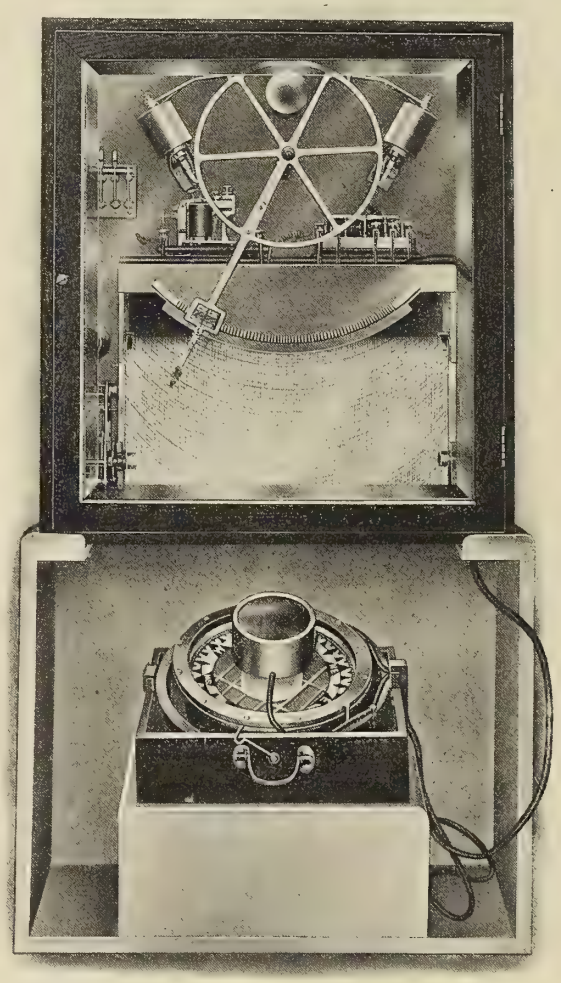
The accompanying illustration gives an excellent idea of the adaptability of Durable wire rope for all sorts of uses in the marine field. This rope is made of selected steel, and each strand is separately served with a specially prepared hemp marline. It combines the pliability and wearing surface of hemp or manilla rope, and is believed to have the strength



of wire rope. Because of the peculiar construction the strength of the wire is preserved far beyond the life of the ordinary wire rope, and the hemp serving binds the wire of the strands together, preventing wear between individual wires and forming a cushion between the strands. As will be seen in the illustration, this rope hugs the bit as closely and as satisfactorily as does the hemp rope also shown. The claim is made that Durable wire rope with a diameter of 1½ inches has an approximate breaking strain of 67,000 pounds, making it equal to a manilla rope over 3 inches in diameter, as regards breaking strain, but the claim is made that it will outlast two or three times the manilla rope. This rope is manufactured by the Durable Wire Rope Company, 90 Pearl street, Boston, Mass.

Schuette Recording Compass.

The Schuette recording compass, which is manufactured by the Schuette Recording Compass Company, Manitowoc, Wis., is so constructed as to produce a continuous record of the direction of a ship with relation to time; so that the direction in which the ship was moving at any hour and minute can be determined at a glance at any time thereafter from an inspection of the records produced. It is claimed that the



instrument shows variations of about two and a half degrees (or a trifle less than a quarter of a point), so that if a ship is on her course and the wheelman lets her go off about two and one-half degrees, the instrument will immediately register the change of direction and also the exact time this occurred, so that a captain, by looking over his chart, can tell whether his ship has been working to starboard or to port, and whether his instructions have been followed. The chart will also show the conditions of the weather, as in a seaway the records will be very irregular, while in smooth water a comparatively straight line will be produced.

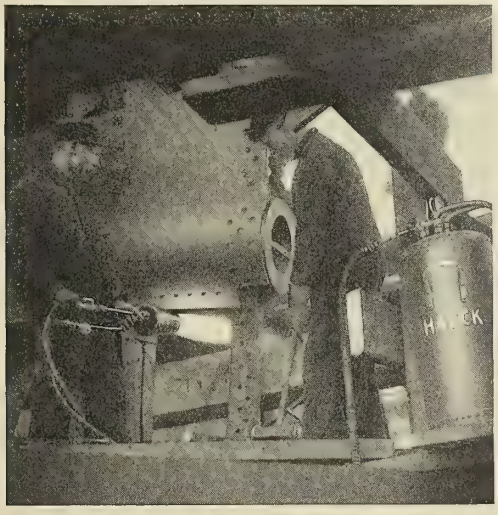
The size of the instrument is 2 feet square by 10 inches deep and it can be connected to any ordinary socket, anywhere on the ship, and any current can be used from 90 to 120 volts; it requires no attention except placing a new chart on the roll every month, and filling the pen about every two weeks. The clock movement which moves the chart exactly 2½ inches an hour is wound electrically and, it is claimed, requires no attention whatever. One of the special features is the cir-

cuit changer, which automatically throws the instrument on a set of batteries if the dynamo current for any reason should give out, and again throws the instrument on the dynamo circuit when the dynamo is again in operation, so that the apparatus in constantly in commission.

The chart will last 31 days and the time and date are printed thereon. The time is graduated to five-minute spaces, so that it is an easy matter to ascertain the time to less than a minute at a glance. All points east of north and south are shaded, while all points west of north and south are clear, so the chart can be read with comparative ease.

Hauck Patent Oil Fuel Burners.

The illustration shows an application of the Hauck portable oil fuel burner, which is useful in shipbuilding work. These burners are manufactured by the Hauck Manufacturing Company, Brooklyn, N. Y., and have been successfully used in various shipyards for heating distorted hull plates, frames and girders; for annealing armor plates; for flanging,



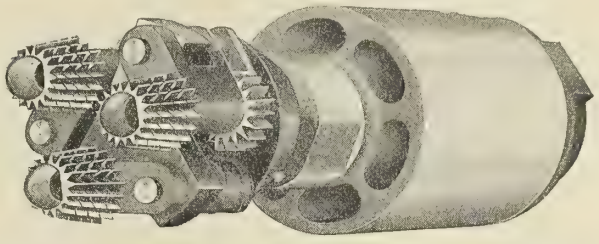
scarfing and shrinking, and for taking off propeller wheels and similar work. It is claimed that their use results in an enormous saving in time and labor. The outfit shown in the illustration is operated by compressed air and the apparatus can be operated under any pressure varying from 5 to 100 pounds per square inch. Any grade of fuel, crude or kerosene (paraffin) oil may be used.

New Form of Head for Boiler Tube Cleaners.

The Lagonda Manufacturing Company, of Springfield, Ohio, has recently brought out a new boiler tube cleaner equipped with what is known as the "quick repair head." This head is attached to the turbine proper by means of the coupling and an adapter. As can be seen from the illustration, which shows a "quick repair head" attached to a Weinland water turbine, a spider screws directly into the coupling, and has three arms on the end of which are attached the swinging arms carrying the cutter wheels. There are four cutters on each swinging arm; the front one being of the cone pattern, is the first to attack the scale and loosen it. Each cone cutter is then followed by three star cutters, which remove the scale down to the metal, leaving a bright, polished surface.

The most important feature of this head is the ease with which new cutters can be inserted. The cutter pin can quickly be removed by means of a wrench and all of the cutter wheels taken out. In case the entire head must be taken apart it is only necessary to unscrew the spider from the coupling; this allows the three arm pins to drop out and the whole head is dismantled. There are no rivets or small parts used, and as the makers furnish an extra supply of sharp cutter wheels with each head there is no reason why any operating engineer should struggle along with a scale remover having dull cutter wheels.

The quick repair head is compact and heavily built. The arms are thrown out against the scale by the action of centrifugal force. This causes the cutter wheels to bear firmly

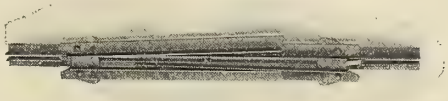


against the scale, but should a constricted part of the tube be met the arms fold in and, it is claimed, do not injure the boiler tube. The flywheel effect of a compact head like this is quite noticeable. When exceptionally hard scale is encountered it is only necessary to back the cleaner out a little and let the head speed up, and when it is again forced against the scale it is generally found that the cleaner will eat its way through without any further trouble.

A Collapsible Steel Horse or Trestle.

A collapsible steel horse or trestle has recently been patented and is now being manufactured by S. M. Hildreth & Company, 2 Rector street, New York City. As can be seen from the illustration, it is a strong, simple, convenient and practical appliance for innumerable uses, such as are builders, carpenters, contractors, machine shops, painters, piano movers, pipe works, manufacturing plants, stores and shops of all kinds, and for various other purposes too numerous to

STEEL COLLAPSIBLE HORSE.



HORSE FOLDED UP.

mention. The horse is made of nickel iron and is, therefore, very rigid and strong, precluding any chance of breakage. It is made in several heights and lengths, suitable for various purposes. The legs fold up when the trestle is not in use, so it can be stored away in a very small space and conveniently handled in transporting. It is claimed that they will withstand more weight than any other horse or trestle of the same size.

Hydro-Tele-Motor Steering Gear.

A new steering gear has been placed on the market by Hanchett & Dannheiser, 237 Fulton street, New York, in which the

power impressed upon the wheel by the hand is transmitted hydraulically to the rudder through small and flexible copper pipes, the advantages claimed being the greater reliability of performance, the elimination of loss of motion and power, and the indifference to atmospheric changes or other weather conditions, while the greater facility with which it can be used in connection with mechanisms for the multiplication of power increases the range of hand-power steering.

The hydraulic principle is shown diagrammatically in Fig. 1, in which are displayed two stationary pistons, which are traversed by a double cylinder. The water, upon operation of the lever handle, comes and goes in the two sides of this cylinder through ducts, which pass along the center of the pistons and discharge into pipes leading to an exactly similar device actuating the rudder. The system being filled with water, it is obvious that when cylinder *A* is moved by means of the lever arm, cylinder *B* must move in the opposite direction a corresponding amount, causing an equal movement of the rudder; also a reverse movement of the lever throws the rudder to the other side. In every case the movements of the

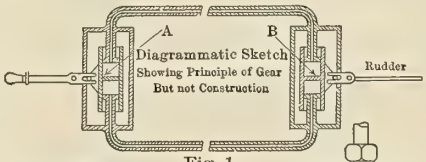


Fig. 1

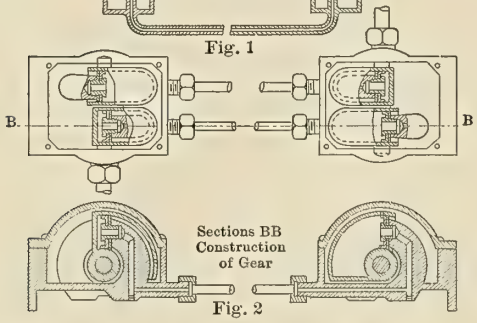


Fig. 2

one cylinder are exactly duplicated by the other. To keep the system supplied with water and to prevent the entrance of air, the cases enclosing the cylinders are filled with water, completely submerging them. Also should water be lost by leakage past the pistons upon a compression stroke, the suction of the next return stroke will restore it, for the cup leather fittings at the piston ends are so contrived that they are slow to allow the escape of water and rapid to permit its ingress. Thus the natural motions of the wheel in steering keep the wheel and rudder in correct relation to each other. In other words the device is self-equalizing.

The device as actually constructed retains the hydraulic principle shown in Fig. 1, but its form is varied to secure mechanical advantages. Thus the cylinders instead of being straight are curved, which permits of their being mounted on a shaft, whereby the oscillations are given a rotary direction. This and other details are shown in plan and section in Fig. 2.

In an installation the two motors are mounted at the steering station and upon the rudder stock, respectively, and are connected by two copper pipes about ¼ inch in diameter. These pipes can be run like wire through partitions, under floors and about obstructions, without joints and without detriment to their serviceability. The fluid used in actual practice is a mixture of alcohol, glycerine and water, that it may be non-freezing. It is said that a helm so equipped has a lightness of touch and a promptness of response hitherto unknown in the steering of boats.

On her final trials, with 27,212 horsepower and 280 pounds per square inch steam pressure, the Brazilian battleship, *Minas Geraes,* made a speed of 21.431 knots, with 147.47 revolutions.

COMMUNICATION.

The Largest Wooden Ships.

Editor International Marine Engineering:

In the issue of your magazine for January, 1910, I notice an article giving a description of the schooner *Wyoming,* which was launched at Bath, Maine, December 15, 1909. In the article it is stated that the *Wyoming* is the largest wooden sailing vessel ever floated, and also that the master builder, Miles M. Merry, holds th etonnage record for square riggers, as well as for fore-and-aft vessels, as it was he that built the ship *Roanoke* for the Sewells some eighteen years ago, which was the largest ship ever built of wood.

I think both of the foregoing statements should be corrected, since nearly fifty-seven years ago on the 4th day of September, 1853, there was launched from the shipyard of Donald MacKay, at East Boston, Mass., a full clipper ship christened the *Great Republic.* She was 334 feet 6 inches long over all, with a beam of 53 feet 6 inches and a depth of 38 feet. Her gross tonnage was 4,555 and she was built of wood. The *Great Republic,* therefore, exceeds the *Wyoming* in size by 825 tons, while she exceeds the *Roanoke* by 1,016 tons. The only dimension in which the *Wyoming* exceeds the *Great Republic* is in the overall length and this is caused by her great overhang, the difference between the overall length and the length of keel being 46 feet, while the corresponding difference in the *Great Republic* was only 16 feet 5 inches, making the length of keel of the *Great Republic* 14 feet 1 inch longer than that of the *Wyoming.* The *Great Republic* was a four-masted vessel square-rigged on three masts.

Capt. E. M. Greenleaf.

Seattle, Wash.

TECHNICAL PUBLICATIONS.

Motor Boats; Construction and Operation. By Thomas H. Russell, M. E., LL. B. Size, 5½ by 7½ inches. Pages, 288; numerous illustrations. Chicago, 1910: The Charles C. Thompson Company. Price, flexible leather binding, $1.50; cloth binding, $1.00.

This book is intended as a guide to the motor boat enthusiast who is not a practical mechanic. It describes a modern motor boat, gives hints on amateur boat building, and takes up in detail marine gasoline engines of all types, including all their auxiliaries. Undoubtedly a large percentage of motor boat owners have little knowledge of mechanics in general, or of gas engines in particular, before they undertake either the building or operation of a motor boat, and such people will find the book of great value. Considerable space is devoted to troubles that are likely to arise in running marine engines and the best way to avoid them.

The Design and Construction of Internal Combustion Engines. By Hudo Güldner. Translated by Prof. H. Diederichs. Size, 8½ by 11 inches. Pages, 672. Illustrations, 728. Folding plates, 36. New York, 1910: D. Van Nostrand Company. Price, $10 net.

Probably nowhere has the gas-engine industry been developed to such an extent as in Germany, and German technical literature on this subject shows the same high degree of development, but prolific as writers have been regarding the gas engine, most of them deal principally with the existing types of engines and the thermodynamic problems involved, and do not take up thoroughly the problems involved in actual design and practical construction. For the practical designer such books are of little help, since he is thoroughly conversant with most of the subject matter himself. Most of the information regarding practical problems of design and construc-

tion of gas engines has been obtained through expensive experimentation and development by individual manufacturers, and, consequently, it has in most cases been jealously guarded and kept for the exclusive use of the manufacturer himself. The author of this book has endeavored to place before the reader a complete practical treatise on the mechanical and kinetic side of gas-engine design and construction, and in this respect the work is unique. The author's personal experience has extended over a great many years of active work as a gas engine designer and builder, and this has enabled him to present a book which is of far greater value than any other publication which has come to our notice in the gas engine field. The book is divided into four parts with an appendix. Part I. takes up the various methods of operating gas engines and the gas-engine cycles. Part II. takes up the design and construction, including the determination of the principal dimensions, general engine parts, special parts for gas and oil engine and auxiliaries. Part III. takes up the construction, erection and tests of internal-combustion engines, and under this head nearly every type of German and American gas engine is illustrated and described. Part IV. deals with gas engine fuels and combustion, while the entire thermodynamic discussion is taken up in the appendix. The book is profusely illustrated, and the translator has added considerable valuable material regarding American gas engine practice.

Olympia Exhibition.

A naval, mercantile marine and general engineering and machinery exhibition will be held at Olympia, London, W., Sept. 1 to 26, 1910. Three years have elapsed since the last engineering exhibition was held at Olympia, and immense strides have been made in marine and mechanical engineering. Since mechanical engineering in all its phases enters into every branch of naval and mercantile marine engineering, it is expected that the forthcoming exhibition will greatly surpass the previous displays of machine tools and general engineering exhibits, and that particularly the prominence given to marine engineering will serve the dual purpose of bringing before shipbuilders and all who are responsible for the administration of naval and mercantile marine affairs the latest and most up-to-date appliances in connection with naval architecture and marine engineering, and also of educating the general public regarding the multitudinous details connected with naval and maritime matters generally

Omission.

In the description of the steamship *Herman Frasch,* which we published on page 66 of our February issue, we omitted to state that the specifications for this vessel were drawn up and the construction work supervised by Jacobs & Davies, Inc., consulting engineers, 30 Church street, New York.

PERSONAL.

Fayette Bown, president of the Brown Hoisting Machinery Company, Cleveland, Ohio, died Jan. 20, 1910, at the age of eighty-seven.

L. D. Mosley, formerly chief engineer of the steamship *Yale* of the Metropolitan Line, has recently been transferred to the steamship *Harvard* of the same line. Mr. Mosley has made a splendid record on the *Yale,* and the transfer was due to the fact that the *Harvard* needed tuning up, and Mr. Mosley was considered to be the best man to put her in shape. E. G. Bernard, formerly chief assistant engineer of the *Yale,* has been made chief engineer of that vessel. We are very glad to see that merit counts.

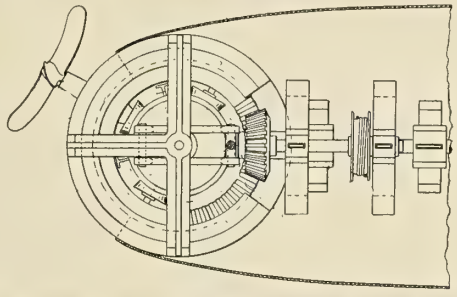
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

940,039. PROPELLING AND STEERING DEVICE FOR VESSELS. WALTER B. MARBLE, OF TACOMA, WASH.

Claim 1.—In a propelling and steering mechanism, the combination with a fixed rotating engine shaft; an angularly adjustable propeller shaft; a set of beveled friction cones and rings adapted to drive the pro-



peller shaft from the engine shaft irrespective of the angular relation therebetween; and means for controlling the angular position of the propeller shaft. Four claims.

937,572. BOILER. HARRY R. BAILEY AND JACOB E. McFARREN, OF MASSILLON, OHIO.

Claim 2.—In a boiler, the combination of an upper drum provided with circulation flues, supporting walls therefor with intervening gas circulation space, lower independent rectangular water headers at front and back having flanges flush with the outer walls, removable cover plates secured to said flanges, water tubes screwed into the inner walls of and connecting said headers, water circulation legs connecting the headers with the lower portion of the upper drum at front and back, and means for producing combustion below the front header and circulation of the gases upwardly around the headers, tubes, water legs and through the circulation flues of the drum. Two claims.

941,776. ANCHOR. MILAN W. HALL, OF BROOKLYN, N. Y.

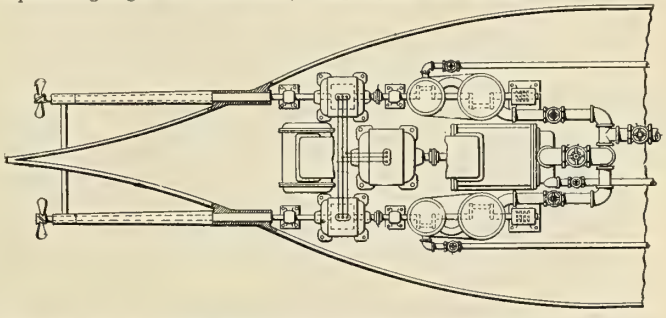
Claim 3.—An anchor comprising a shank, a mushroom head and a plurality of independent pivoted flukes, the palms of the said flukes being arranged, when in their operative positions, to lie in the line, and to form a substantial continuation, of the mushroom head. Fifteen claims.

943,604. SUBMARINE BOAT. RAYMOND D'EQUEVILLEY-MONTJUSTIN, OF KIEL, GERMANY.

Claim 1.—A submarine boat having a conduit in communication with the outer water and through which water is made to circulate to develop the diving action, the lower portion of said conduit leading in a substantially vertical direction from the bottom of the boat, and means causing a flow of water through said conduit, acting upon the water within said conduit in a direction substantially transverse to the diving direction whereby the reaction of said means is not exerted in a direction to influence the living action. Eight claims.

945,925. SYSTEM OF POWER DISTRIBUTION. WILLIAM L. R. EMMET, OF SCHENECTADY, N. Y., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—In a power system for propelling ships, the combination of twin shafts, a propeller on each shaft, a low speed, high pressure reciprocating engine on each shaft, a high speed, low pressure turbine that



is driven by the engine exhaust, an electric generator driven by the turbine, electric motors constructed and organized to operate at the same speed which are mounted one on each of the said shafts and co-operating with the engines to drive the shafts, and conductors conveying current from the generator to the motors in multiple. Fifteen claims.

942,855. ANTI-DRIFTING DEVICE. ELIAS GUNNELL, OF MANITOWOC, WIS., ASSIGNOR TO MANITOWOC DRY DOCK COMPANY, OF MANITOWOC, WIS., A CORPORATION OF WISCONSIN.

Claim 1.—The combination with a scow having an open bottomed dumping well extending throughout its length, of an anti-drifting flap hinged on a vertical axis and lying in the well, and means whereby the flap may be held in a position transverse to the well. Six claims.

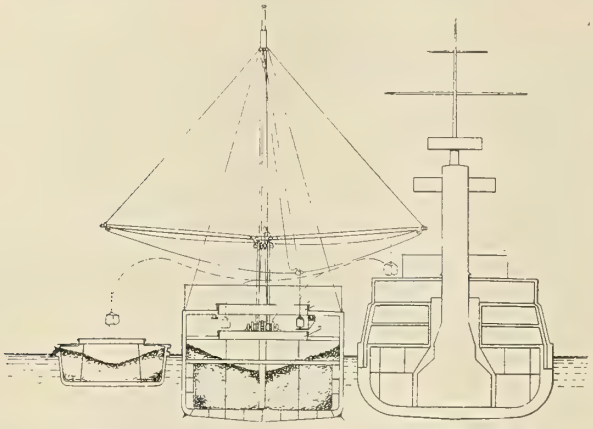
943,833. AIR HEATER FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF NEW YORK, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 2.—In an automobile torpedo the combination with the reservoir of air under high pressure, the engine, the conduit leading from the

reservoir to the engine, the reducing valve in said conduit, the heater in communication with said conduit on the low pressure side of said valve, and the fuel tank, of a valve controlled by the relative pressures in the heater and fuel tank, and controlling the flow of high pressure air to said tank. Four claims.

943,694. COLLIER AND COAL-HANDLING APPARATUS. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

Claim 18.—In a boat, in combination, two rope-drum engines located on opposite sides of a hatchway, a hoisting rope extending from a drum of the first engine over an elevated sheave from which its fall is pendent



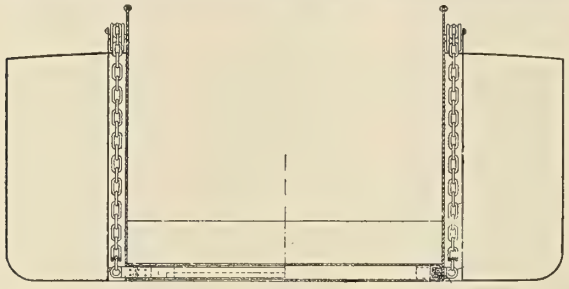
through said hatchway, a swinger guide engaging said fall, a rope connecting said swinger guide with a drum of the first engine and a rope connecting said guide with a drum of the second engine. Fifty-six claims.

945,123. PROPELLER. FYNIS C. GORDON, OF CLEVELAND, OHIO, ASSIGNOR TO GORDON PROPELLER COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

Claim 1.—In a reversing propeller, the combination with a main shaft, a spherical head secured thereto and provided with recesses, a gear disposed in one of said recesses and the ends of propeller blades disposed in other of said recesses, said ends being provided with teeth arranged to mesh with teeth on said gear, and a two-part casing provided with openings to permit a portion of said gear and said blade ends to project therethrough, said casing having threaded extensions arranged to receive retaining nuts. Three claims.

946,059. HOPPER DREDGER AND BARGE. FRED LOBNITZ, OF CROOKSTON, SCOTLAND.

Claim 1.—A hopper barge or dredger having, in combination, a hopper with sides which extend straight down at the bottom thereof, transverse

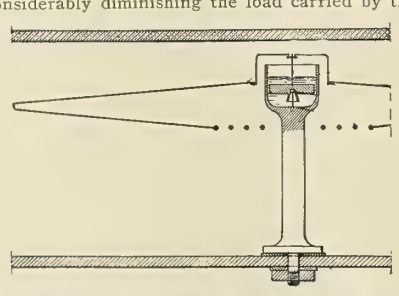


hopper doors adapted to close tightly against said straight sides, lugs on the sides of the hopper doors at the closing edges thereof and adapted to pass through the side of the hopper, and means external of the hopper for operating said doors. Two claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

18,615. MARINERS' COMPASS. L. D. J. A. DUNOYER, VERSAILLES, FRANCE.

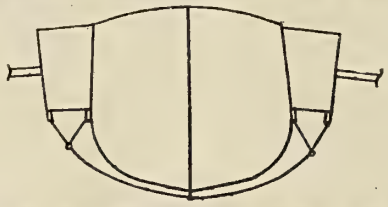
This invention consists in retaining dry cards with a weak magnetic moment; remedying their lack of sensitiveness due to the friction of the pivot by considerably diminishing the load carried by this pivot, and



consequently proportionally reducing the wear of the pivot. This is done by carrying the larger portion of this load on a float plunged in a bath of liquid, such as mercury arranged at the center of the card, so that the load carried by the pivot may be only a small fraction of the total load.

21,348. RAISING SUNKEN VESSELS. R. J. TRELEAVEN, LEYTON.

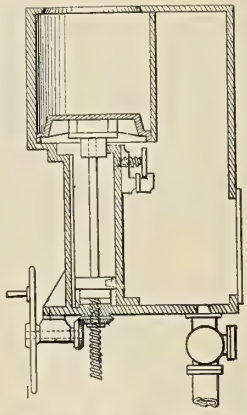
Flat sided receptacles, open at their lower ends, are attached around the exterior of the vessel to be raised, which contain inflatable balloons, or the like. Such balloons are inserted in receptacles, prefarably of metal, and of triangular section, enlarged at their upper end so that



when the balloons are inflated they will rise with this end uppermost, their flat faces against the sides of the vessel. The balloons may be secured within cases and a connector be fixed in the body. The panels of the cases might be made of chain or rope netting.

5,832. SUBMARINE BOATS. J. FRASER, GLASGOW.

Relates to a means of escape from submarines. The apparatus is first closed by raising a door to shut the port, then the screw is turned to engage the hole, and so keep the door closed. The water is then



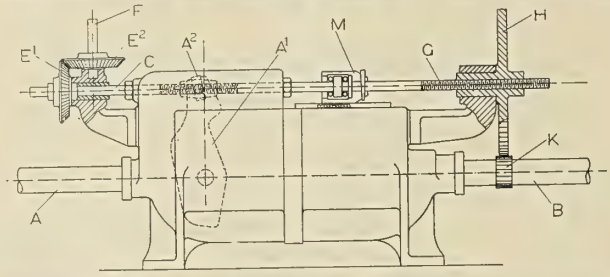
cleared out by means of an air pipe. A person wishing to escape enters by the door, which he closes tightly and retracts the screw to allow the door to drop so that he may escape by the opening. The above cycle of operations is repeated for the next person leaving.

21,899. PROPULSION OF VESSELS BY HIGH-SPEED ENGINES AND MOTORS. G. L. M. DORWALD, LONDON.

This invention provides for running the engine at its maximum and most economical speed, and a propeller of a large diameter at a reduced speed, with a propelling effect in proportion to the power of the engine. Thus the advantages of maximum speed of engine and better relation between area of propeller and cross-sectional area of the vessel are combined. Where twin screws are used, the engine shaft has a double clutch, either portion of which can be brought into action. Attached to each part is a sprocket wheel, and on each of the propeller shafts is a sprocket wheel, both wheels operable by chains, the diameters of the sprocket wheels giving the required speed to the shafts. The propellers are of opposite pitches, one right handed and the other left, and their shafts are geared together so that they rotate in opposite directions. The direction of rotation of the shafts therefore depends on which portion of the clutch is in action.

26,060. SHIP'S STEERING APPARATUS. A. F. PETCH, WESTMINSTER.

The invention consists in a combination of a constant-speed motor or engine with variable rotary-speed hydraulic transmission device consisting of a variable delivery hydraulic pump and hydraulic motor, the transmission device being controlled by means of a hand steering wheel



and hunting gear. E^1, E^2 are the hand steering gears operating shaft C, which is screwed to engage a nut A^2 for inclining a member A^1, on the angle of which the rotation of shaft B depends. This shaft operates the steering gear and carries a pinion engaging a wheel H, whose hub is the nut of a screwed part of the shaft G, which does not rotate, but is coupled at M to the shaft C.

26,570. MEANS FOR LOCATING SUNKEN VESSELS. N. KRAVTCHENKO, ST. PETERSBURG, RUSSIA.

The invention relates to a buoy furnished with a lamp and a telephone. This buoy is carried by the submarine and is attached by a cable to a drum, the axis of which is used as a passage for conducting wires. When the submarine sinks, the buoy is freed by one of the imprisoned crew, and, uncoiling the cable from its drum, rises to the surface, automatically lighting the lamp. Rescuers, seeing the light, locate the ship at once, and may communicate with the crew after unscrewing the cap on which the telephone is hooked.